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DECEMBER, 1922 Number 4

# MACHINERY

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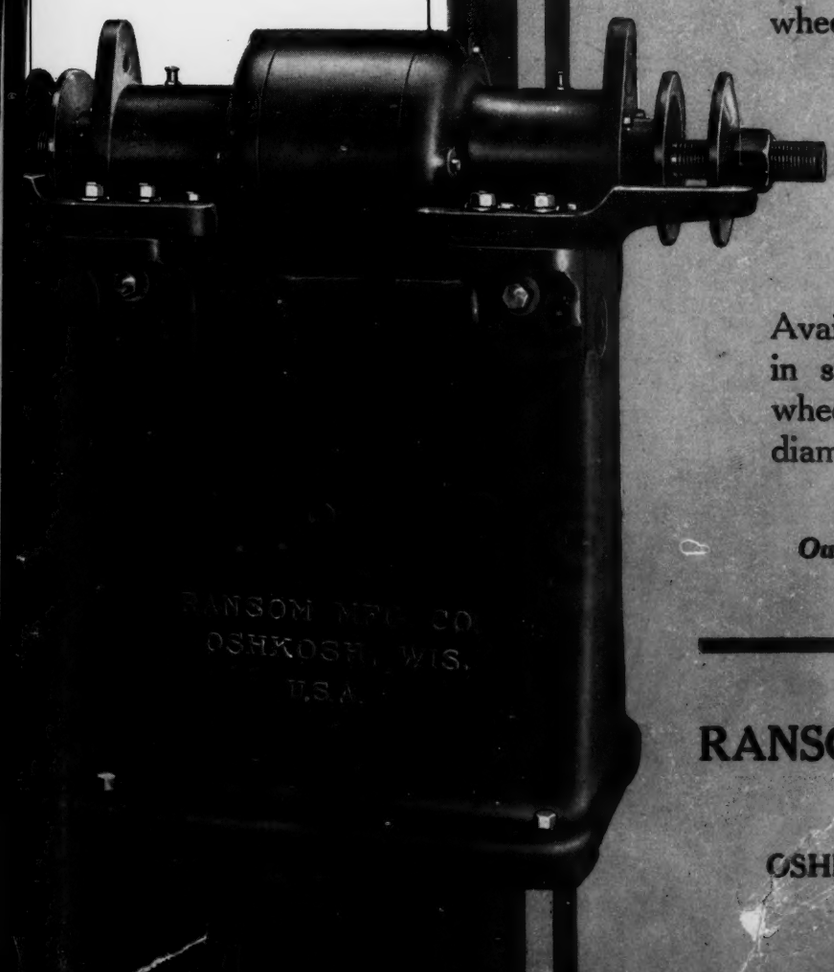

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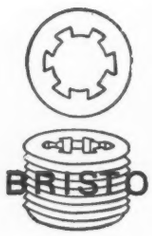


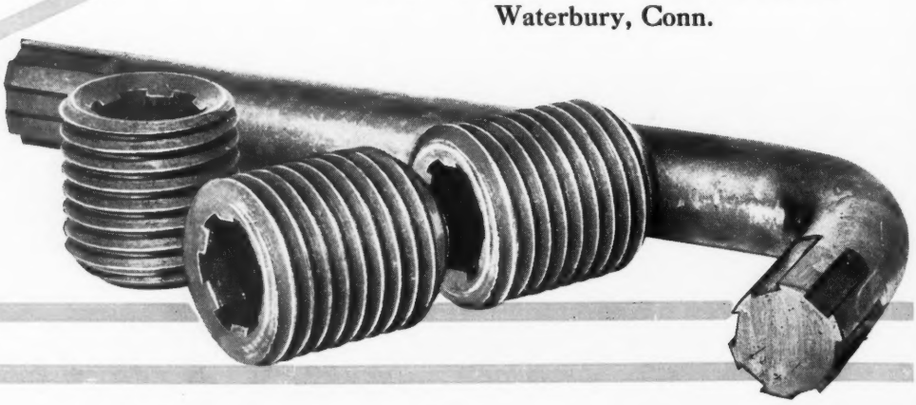

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SIMONDS

VOLUME 29

# MACHINERY

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DECEMBER, 1922

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January MACHINERY will deal with a wide variety of subjects — Sectional Blanking and Piercing Dies, Hydraulic Bulging and Bending, Dies for Die-castings, Spinning Chucks and Grinding Large Engine Cylinders

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# *Coming*

**In December**

"The Simmons Method of Hob Making."

"Equipment for Making Die Castings."

"Development in Die Casting Practice."

"Machine Tool Investments."

A number of articles on current shop practice.

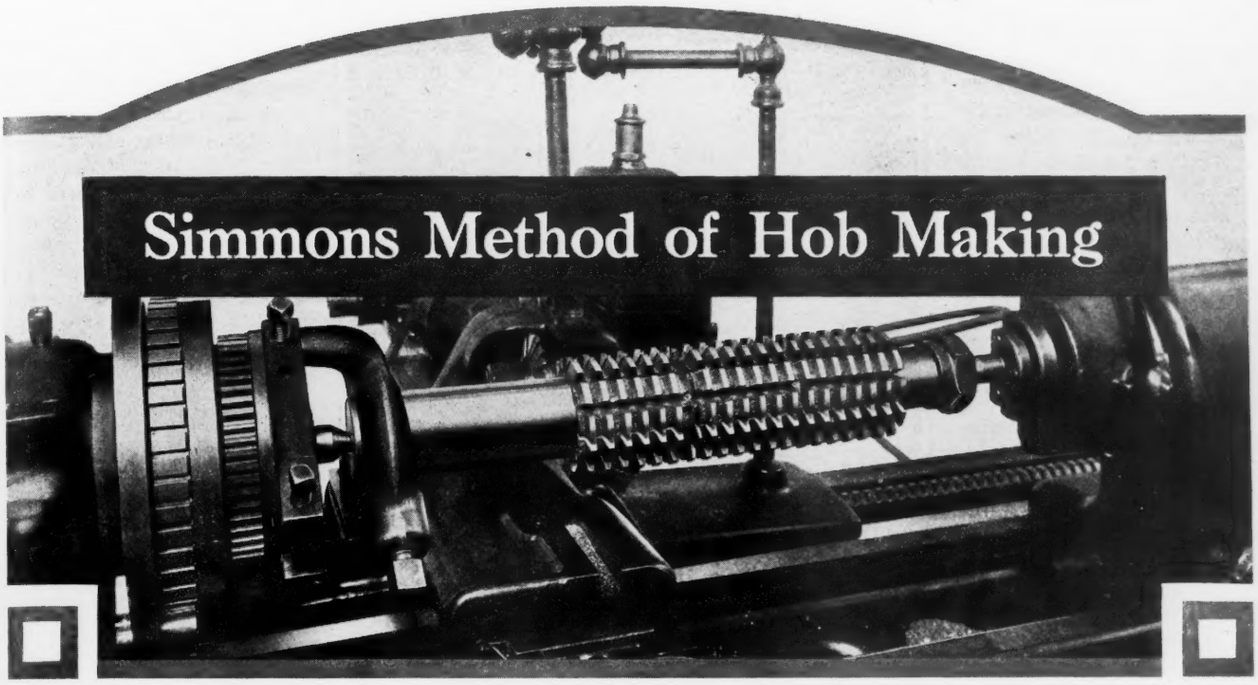
Descriptions of interesting new machines and tools.

Foreign Notes. Trade News.

MACHINERY is an educator. Every number is planned to give the reader the greatest possible amount of information on subjects vital to his daily work.

The current number, December, is a particularly good example of its value as an educational factor. For instance, the method developed by Oliver G. Simmons of Philadelphia for simultaneously generating and relieving the teeth of gear hobs, described for the first time in its entirety. The articles on die casting practice and equipment—particularly valuable because this development within the metal working industry is so recent, so successful, so diversified in its possibilities—a field in which great things have been done and greater are to come. And for the executive, an article on page 279, written by an experienced sales manager who has given the selling of machine tools his best efforts for many years, will make good reading.

# JANUARY, 1923



# Simmons Method of Hob Making

## A Method of Simultaneously Generating and Relieving the Teeth of Gear Hobs with a Revolving Cutter Resembling a Spur Gear

By CHARLES O. HERB

GEAR hobs generally have the threads cut by chasing in a lathe or milling with a formed cutter in a milling machine. Then, after gashing the flutes and heat-treating the hob to remove internal strains set up by the preceding operations, the teeth are relieved to provide peripheral and side clearance. Subsequent operations include hardening, tempering, and grinding.

The main point of difference between the manufacturing process developed by the Simmons Method-Hob Co., Philadelphia, Pa.,* and the procedure outlined is in the relieving step. In the Simmons method, a standard worm thread is first milled on the hob in a thread milling machine by means of a straight-sided formed milling cutter. After heat-treating, this preliminary thread is generated to the true tooth form in the relieving step by the action of a rotating cutter somewhat similar to that employed on the Fellows gear shaper. This cutter is inclined so that as each tooth engages the work the face is in a plane at right angles to the helix of the hob thread. Thus the hob teeth are "generated" rather than "formed." The rear view of one of these cutters is shown at *A*, Fig. 1. The teeth are of the true involute form and will mesh with standard gears of the same diametral pitch. The front face of the cutter teeth has a rake of about 5 degrees.

*All the manufacturing rights of the Simmons Method-Hob Co. have been acquired by the National Tool Co., Detroit, Mich., since this article was written.

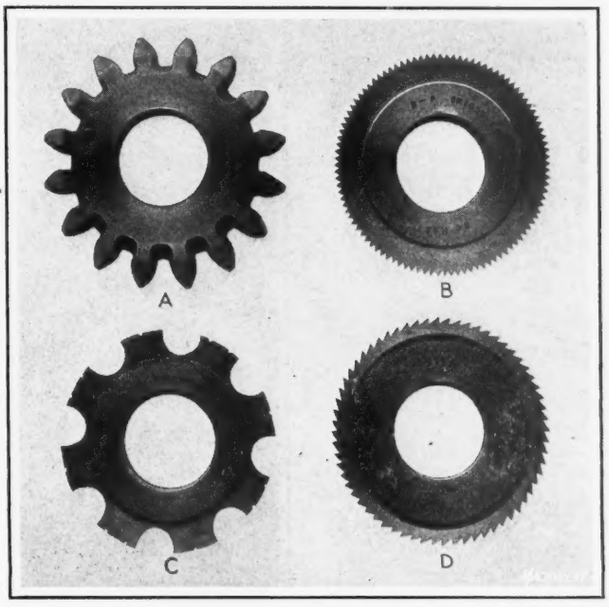



Fig. 1. Cutters used for generating and relieving Hob Teeth

The relieving operation is performed in a lathe equipped with a standard relieving attachment and a special attachment, mounted on the carriage, which rotates the cutter in the correct relation to the work. Another operation of particular interest is the grinding of the cutter teeth, which is done in a machine designed especially for this purpose. This article will describe the different steps in the manufacture of both hobs and cutters. The Simmons method is applicable to the manufacture of hobs of all types for producing the teeth of spur, helical, worm and Hindley gears, hacksaw blades and ratchets, and for milling threads and splines. Gear hobs may be made with single or multiple threads, and other types may be made with or without lead, and with the teeth staggered or in a straight line.

### Preliminary Operations—Drilling, Turning, and Boring

After the round stock from which a hob is to be made has been cut to length, it is rough- and finish-drilled in a Baker vertical-spindle drilling machine. The jig illustrated on the table of this machine in Fig. 2 is used in drilling stock of any diameter, and insures that the stock will be drilled at the center. As this jig is adaptable to drilling many other kinds of work, its application will be described in detail.

The first piece of a hob lot of one diameter has the center located by means of a common center square, after which it is clamped in the vertical vee of base *A*. A plain center *B* which accurately fits the bushing in the front end of the sliding bar *C* is then inserted in this bushing. The sliding bar is next pushed back and forth until the point of the center registers at the intersection of the scribed lines used in determining the center of the work. Bar *C* is then clamped, center *B* removed, the jig shifted to bring the bushing directly beneath the machine spindle, and the hole drilled.

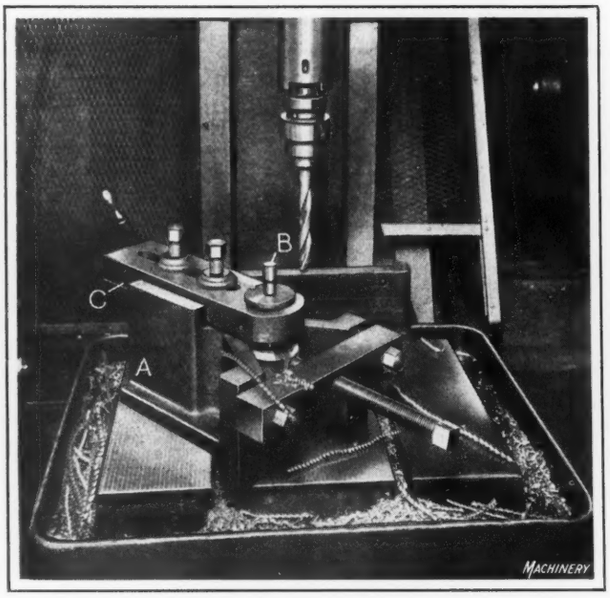



Fig. 2. Jig for drilling the Bore in the Hobs

It will be obvious that any number of pieces of the same diameter may now be drilled without changing the setting of the sliding bar and without first scribing lines on the work to determine the location of the center. When the hole in the hob is to be 1¼ inches in diameter after grinding, it is rough-drilled to ¾ inch in diameter, then to 1 7/32 inches in diameter, and finish drilled to 1.240 inches in diameter. In the latter step, use is made of a three-fluted drill which has the lands ground in such a manner that a reamed finish is obtained. It is, of course, necessary to substitute bushings in the sliding bar of the right size to accommodate the larger diameter drills used in the second and third steps.

The part is next mounted on an arbor in a lathe for turning the cylindrical surface, and then placed in a drawback adapter which fits the collet chuck of another lathe. Both ends of the work are then faced, and the hole recessed for about one-third its length at the middle. The edges of the hole are also beveled slightly on each end to permit the seating of a 60-degree conical center in a later operation. In performing these steps, it is necessary to change the work end for end in the collet chuck. Cutting lubricant is supplied copiously in this as well as in all the succeeding machining steps.

### Milling the Thread and Gashing the Flutes

From this stage of the manufacturing process and until the hobs leave the relieving machine, they are mounted three at a time on a hardened and ground arbor for the different operations. This results in a higher rate of production than would be possible if the hobs were handled individually. The next two operations consist of milling the thread in a Pratt & Whitney thread milling machine, and gashing the flutes on a Becker milling machine. Either of these operations may be performed first, the choice depending upon which type of machine happens to be ready to receive work. The heading illustration shows the thread milling machine set up for cutting a thread on three hobs after the flutes have been gashed. This is a 29-degree worm thread, and is produced by a staggered tooth cutter. The hobs are of 5 diametral pitch and were milled in approximately three hours.

All Simmons hobs on which the helix angle of the thread is less than 5 degrees are gashed straight, that is, parallel to the axis. Those with a helix angle of 5 degrees or greater are gashed spirally or at right angles to the thread helix. Theoretically, the flutes of all gear hobs should be spiral to obtain the most efficient cutting action, but because most shops are not equipped for grinding spiral-gashed hobs as they become worn, the hobs are gashed straight until the helix angle becomes so great that the non-uniform cutting action of straight-fluted hobs would be unsatisfactory. A prime number of flutes is always cut on Simmons gear hobs for a purpose which will later be mentioned in connection with the relieving operation.

For gashing the flutes, the work is supported on the centers of an index-head and footstock, as illustrated in Fig. 3, and indexed in the ordinary manner. The hobs illustrated are of 5 diametral pitch, and have eleven flutes.

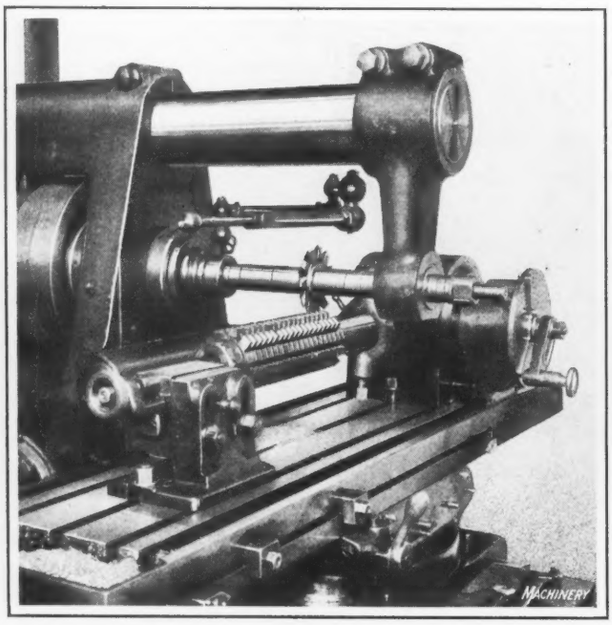



Fig. 3. Gashing Straight Flutes across Hobs on an Arbor supported by an Index-head and Footstock

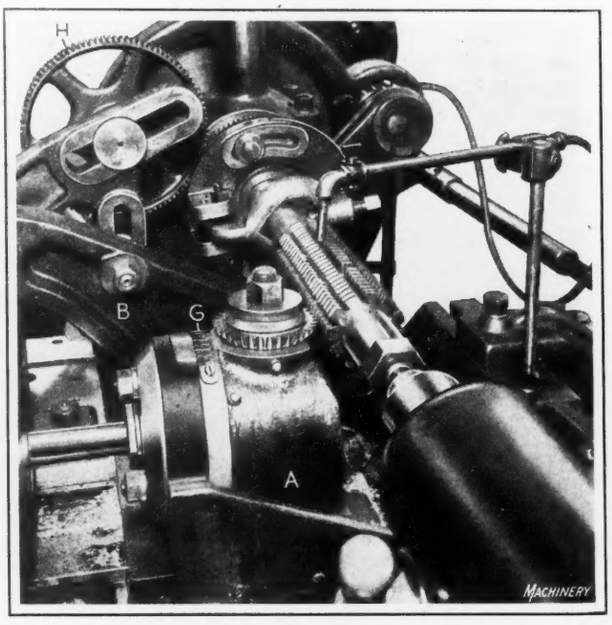



Fig. 4. Generating and relieving Hob Teeth by employing a Revolving Cutter and a Standard Relieving Attachment

The cutter has an included angle of 33 degrees between the tooth faces; however, cutters with angles anywhere between 20 and 40 degrees are used. The cutting time for this operation was two and one half hours, only one cut being taken across each flute.

### Heat-treating to Relieve Internal Strains

The hobs are next packed in containers with pulverized willow charcoal for annealing. They are heated to from 1550 to 1660 degrees F. in a Leeds & Northrup electric furnace, and allowed to cool in the container. They are then removed from the container and heated slowly to from 1300 to 1350 degrees F., this heat being maintained for one-half hour, after which they are cooled in dry air. While they are cooling, special care is taken to protect the hobs from cold drafts and a chilled floor.

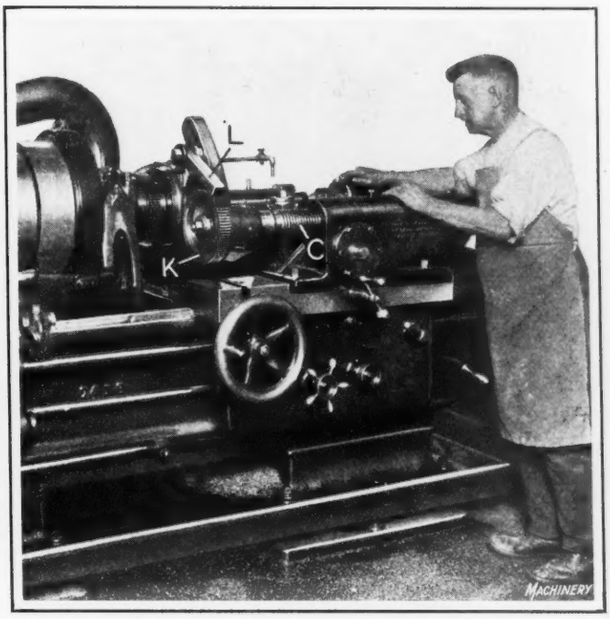



Fig. 5. Front View of the Special Hob-tooth Generating Attachment, showing the Driving Gear disengaged

### The Generating Mechanism

The generating and relieving operation is performed on a Hendey 24-inch lathe equipped with a Hendey Style D relieving attachment, and the Simmons special attachment previously mentioned, which may be seen in Fig. 4. It consists essentially of a cutter-head *A*, mounted on a special cross-slide of the lathe and a unit attached to the front of the carriage for transmitting the rotary motion to the cutter. Power is delivered to this unit by means of a gear on the headstock spindle directly in back of the faceplate which meshes with idler gear *H* on bracket *B*. This idler gear, in turn, drives a gear *K* on the forward end of the large screw *C*, Fig. 5, which is also designated by the letter *C* in Fig. 6.

From this screw, power is transmitted through worm-wheel *D* and sliding shaft *E*. At the cutter head end of the sliding shaft is an integral bevel gear which meshes with a second bevel gear on the lower end of cutter-shaft *F*. By designing shaft *E* to slide through worm-wheel *D* the cutter may be moved toward the work at the same time that the carriage is operated along the ways of the bed, either by hand or by means of the feeding mechanism. The gear at the end of screw *C* is chosen to suit the cutter and has two and one-half times as many teeth as are in the cutter.

After the cutter has been set properly relative to the hob teeth and gashes, and the dog on one end of the work-arbor has been clamped to the faceplate to eliminate lost motion, if the cutter is moved away from the work, along the bed, and then forward toward the work again, its teeth will always properly engage the spaces between the hob teeth. This is certain, because the rotation of the cutter and the rotation of the hob are always correlated. When the carriage is moved along the bed, the cutter rotates faster than when the carriage is stationary, due to the rolling of worm-wheel *D* on screw *C*.

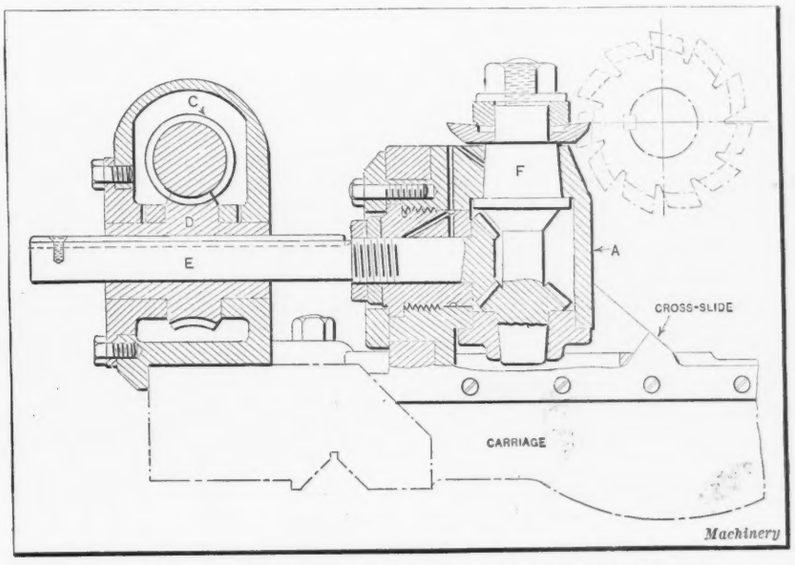



Fig. 6. Cross-sectional View through the Cutter-head and Driving Unit of the Special Generating Attachment

### Generating and Relieving Gear Hobs

In arranging the generating attachment for an operation, the helix angle of the hob teeth is first determined and then the cutter-head is swiveled in its bracket to this angle and clamped by means of nuts on bolts at the rear of the head. Graduations at *G*, Fig. 4, insure a close setting. Shims are placed beneath the cutter to raise it so that a radial center line through each tooth at the top cutting edge will be on the same horizontal plane as the axis of the work when the tooth center line also coincides with the helical center line of a space between two hob teeth. The dog on the work-arbor is then clamped to the faceplate, and one tooth of the cutter is meshed between the teeth of the hob and fed to depth, after which the cutter is clamped in position.

The relieving attachment at the rear of the machine is next set to move the cross-slide of the lathe in and out so that the cutter will form a peripheral, side, and bottom relief on the hob teeth. The number of these reciprocations per revolution of the work is one-half the number of flutes, and the cutter is withdrawn sufficiently so that when it again contacts with the hob teeth it has skipped one flute, and thus cuts alternate rows of teeth. A micrometer stop provides an accurate means of controlling the stroke of the cutter-head. By machining alternate rows of teeth in this manner there is ample time to again feed the cutter to the cutting point after it has been withdrawn.

The teeth that are skipped on the first revolution of the hob are generated and relieved during the second revolution. If the hobs had an even number of flutes, this procedure could not be followed, and it is for this reason that all Simmons hobs are made with an uneven number of flutes. Three cuts are taken across the hobs with the same cutter—two roughing and one finishing cut. The hobs illustrated in Fig. 4 are for cutting 8 diametral pitch, spur or spiral gears of 14½ degrees pressure angle, and they have eleven gashes. The relieving attachment is set for operating five and one half times per revolution of the work. In this case, the helix angle of the hob teeth is

2 degrees 26 minutes, and hence the cutter-head is swung to this angle.

During the first and second cuts the carriage is fed 0.010 inch per revolution of the work, while during the finishing cut the feed is preferably 0.005 inch per revolution, the work in each case revolving about sixteen times per minute. The amount of peripheral relief is ¾ inch per complete revolution of the work; that is, if the relieving cutter were permitted to cut an uninterrupted spiral, the lead of this spiral per revolution of the work would be ¾ inch. The diameter of the hob has no influence on the selection of the generating and relieving cutter. These three hobs are generated and relieved in approximately four hours.

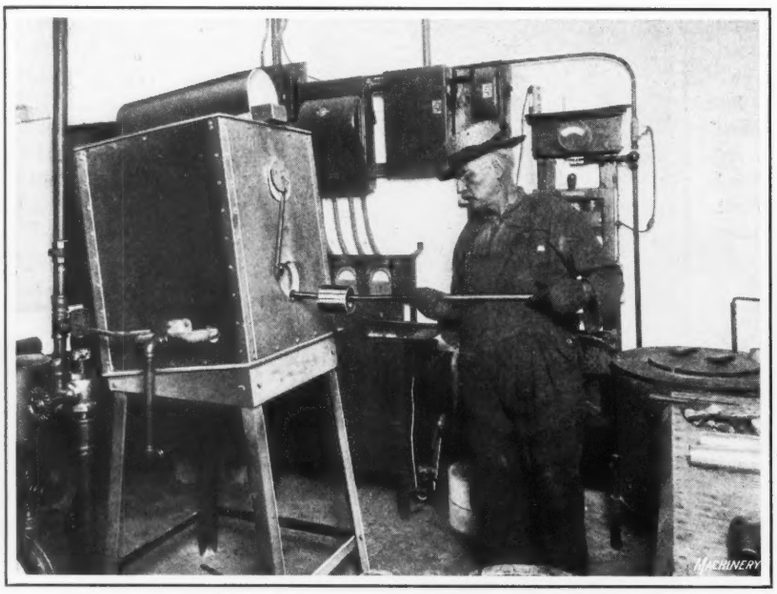


Fig. 7. View of the Hardening Room, showing a Hob being removed from the High-temperature Chamber of the Muffle Furnace

### Generating and Relieving Other Types of Hobs

The procedure in generating and relieving hobs for common worm-gears is similar to that outlined, but for Hindley worm-gears the lathe carriage is stationary, and the rotating cutter is automatically fed into the work to the required depth. Hobs having no lead, such as those for threads, or hacksaw blades, come to the generating and relieving machine without a preliminary thread milling operation, the teeth being completely generated and relieved in this step. A cutter for producing a hob for Briggs pipe threads is shown at *B* in Fig. 1. The cutter at *D* is for producing hobs for hacksaw blades. As these hobs are without lead, the cutter does not rotate in generating and relieving, except as it is revolved by the action of worm-wheel *D*, Fig. 6, in running along screw *C* when the carriage is fed along the bed. For this reason, the idler gear *H*, Fig. 4, is replaced by bar *L*, Fig. 5, which has a special tooth at the front end engaging the teeth on gear *K*. The bar is clamped in this position to prevent the screw from revolving during an operation. The cutter is fed only once across the hobs in producing thread milling and hacksaw blade hobs.

Hobs having no lead, but with the successive rows of teeth staggered, as on hacksaw blade hobs, can be conveniently made with an even number of flutes. In this case the relieving mechanism is again set so that the cutter engages alternate rows of teeth, but the intermediate rows are not machined until after the cutter has been traversed the length of the hobs. The front section of the faceplate is then loosened and swiveled sufficiently so that when clamped again and revolved, the cutter teeth will engage the intermediate rows of hob teeth. On a sixteen-flute hob, the faceplate would be indexed 1/16 revolution. This adjustment is facilitated by graduations on the faceplate.

The cutter must also be indexed one-half the circular pitch of the teeth to properly engage the teeth in the second series of rows. The indexing of the cutter is accomplished by unclamping gear *K*, turning it a sufficient amount, and then clamping it again. The cutter illustrated at *C*, Fig. 1, is employed for producing hobs for splining an automobile transmission shaft. The rounded teeth of hobs made by means of this cutter have a radius of ⅜ inch. The small recesses on the teeth of the cutter break up the chips in the generating and relieving operation.

### Broaching, Hardening, and Tempering

A keyway is broached in the holes of the hobs as they leave the relieving machine, after which the hobs are

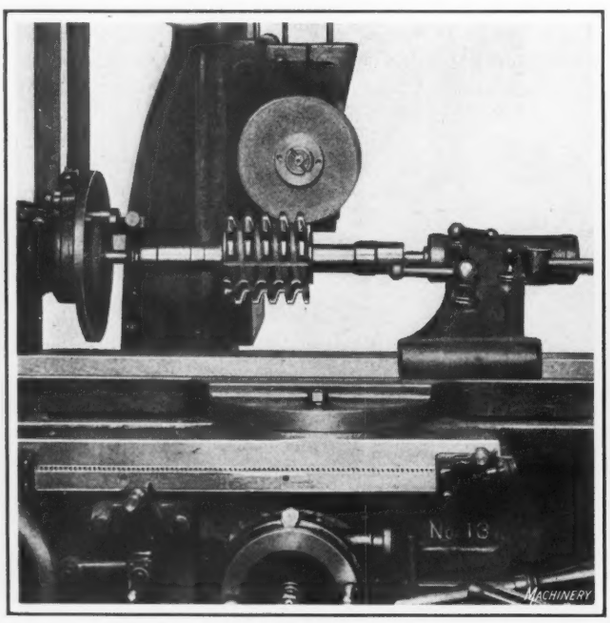


Fig. 8. Grinding the Tooth Faces

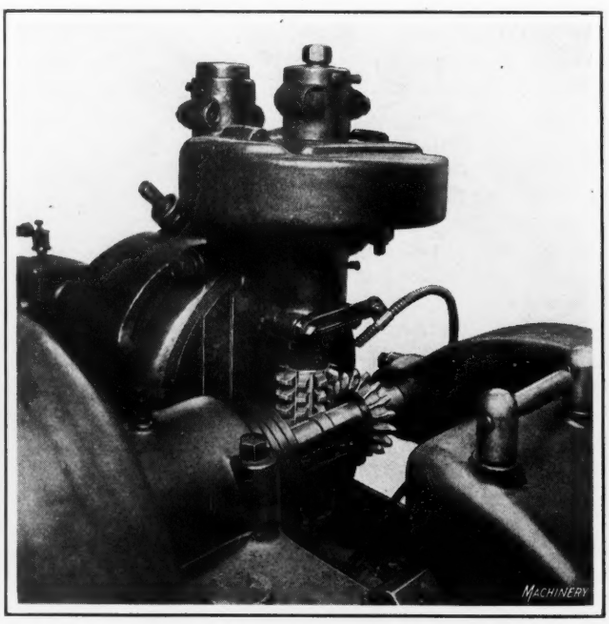


Fig. 9. Hobbing the Cutter Teeth

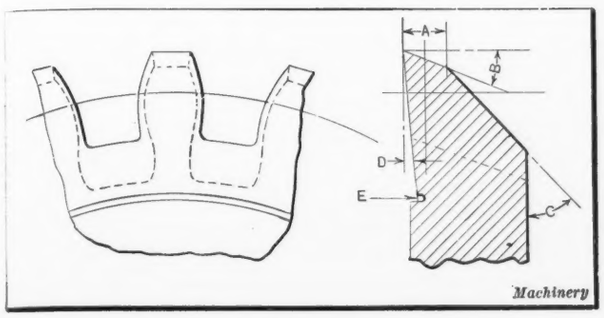



Fig. 10. Design of the Teeth on a Cutter for Spur- and Spiral-gear Hobs

taken to a stamping machine, where the dimensions, type and similar information are stamped on one end. All high-speed steel hobs are then hardened in the special three-compartment furnace seen in the foreground in Fig. 7. This furnace is of the muffle type and has an atmospheric control. It may use either gas or oil for fuel, the former being used in this installation. There are two burners on each side of the furnace and a pilot light on the left-hand side.

The hobs are given a preliminary heating in the compartment at the top of the furnace in which a quantity of hobs may be placed at one time. They are heated slowly in this chamber until they reach a temperature of approximately 650 degrees F., and are then removed to the intermediate chamber which is heated to about 1650 degrees F. The hobs remain in this chamber for about four and one-half minutes and are then finally placed in the high-temperature compartment, the approximate temperature of which depends upon the steel, but which ranges from 2250 to 2400 degrees F. They also remain in this compartment for about four and one-half minutes.

While in both the intermediate and the high-temperature chambers, the hob is supported on a bar which is revolved continuously in the hands of the attendant. The heating of the high-temperature compartment to 2300 degrees F. from the normal room temperature, consumes about 410 cubic feet of gas, and takes about 1 hour and 45 minutes. For the maintenance of this temperature, about 260 cubic feet of gas per hour is consumed. The design of the furnace is such that when the high-temperature chamber reaches the desired temperature, the intermediate and low-temperature chambers also reach the desired temperature.

When the hobs are removed from the high-temperature chamber they are quenched in oil heated to 300 degrees F. They are then allowed to cool in a receptacle which protects them from drafts. After cooling, the hobs are tempered by reheating to a temperature of 1050 degrees F. in a Leeds & Northrup electric furnace, and again permitted to cool in dry air. Carbon-steel hobs are hardened by quenching in oil, after having been heated to from 1450 to 1540 degrees F. in the electric furnace, and they are then tempered by heating to from 350 to 450 degrees F. in the same furnace and cooling in dry air.

After tempering, the hobs are free from scale, but they are of a bluish black color. They are cleaned to a gray color by a sand-blasting operation in which steam of 90 pounds pressure and powdered sand are used; this operation is called the "mud bath," because it is essentially a scouring or cleaning process.

### Final Grinding Operations

After the mud bath, a number of dry grinding operations are performed on each hob, a B. & S. No. 13 universal grinding machine being used. The first step consists of grinding the hole; during this operation one end of the hob is seated on a conical center in the index-head by means of the 60-degree bevel which was machined at the edge of the hole in the boring step and which was polished after tempering. The other end of the hob is supported by a steadyrest. With this set-up it is necessary to turn the hob end for end in order to grind both ends of the hole. The internal grinding attachment is, of course, mounted on the machine.

The external grinding attachment is then mounted on the machine, and the hob is placed on a drawback adapter for grinding the hub face and the narrow shoulder on each end. These shoulders provide a means of accurately setting up the hob in hobbing machines. Finally, the hob is mounted on an arbor, as illustrated in Fig. 8, for grinding the face of the teeth. This is done by traversing the work past the wheel and indexing for each flute. Both straight- and spiral-gashed flutes can be ground on this machine. Every hob is later tried out in a hobbing machine, and the work produced is checked to determine the accuracy of the hob.

### Design of Hob Cutters

Cutters for producing gear hobs of from 3 to 7 diametral pitch are made about 6 inches in diameter, and those for hobs of 8 diametral pitch or over are about 4 inches in diameter, the exact diameter depending upon the number of teeth and the diametral pitch. Cutters for thread-milling and hacksaw-blade hobs are also made 4 inches in diameter. Dimension *A*, Fig. 10, represents the width of tooth allowed for regrinding gear hobs, and is ¼ inch. Angle *B* is 20 degrees on all hobs, and angle *C*, 45 degrees on gear hobs only. On other hobs, the surface of relief is continued to the back of the hob. Angle *D*, as previously mentioned, is usually 5 degrees for gear hobs, and 10 degrees for thread-milling and hacksaw-blade hobs.

It will be seen from this illustration that the depth of the tooth remains the same as the tooth faces are reground, but as the pitch diameter of the teeth also remains the same, the tooth addendum is decreased, and the dedendum increased. In order to compensate for the difference that will exist in a new and a nearly worn out hob, the plane where a cross-section through a tooth is of standard dimensions, is located one-half of the distance *A* from the tooth face, before any regrinding. About 0.001 inch of stock is removed from the cutter teeth in sharpening, and each cutter will produce from 200 to 240 hobs.

The cutters are made from forged disks, it having been found more satisfactory to purchase the disks in this form

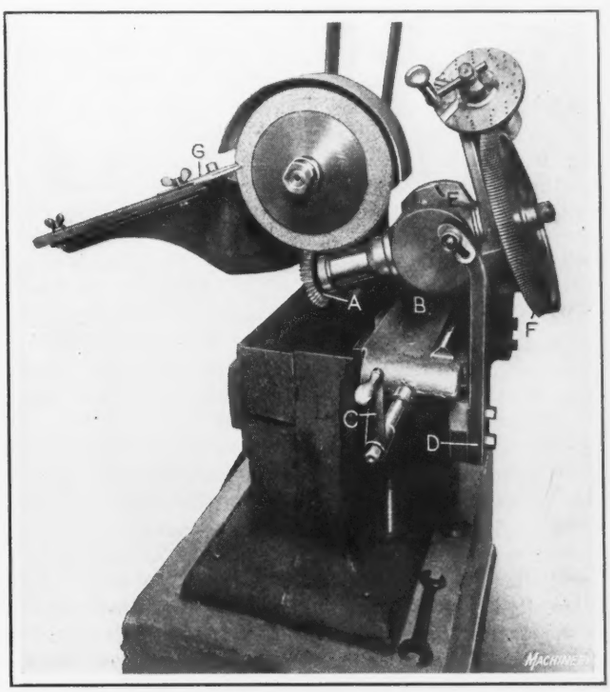



Fig. 11. Special Machine designed for grinding the Profile of the Cutter Teeth

than to cut them from bar stock. The disks are rough-drilled by using the fixture illustrated in Fig. 2, rough-faced on both sides, and rough-turned in a lathe, given an annealing similar to that described in connection with the hobs, and then permitted to season. The next step consists of finish-boring, finish-facing both sides and finish-turning the peripheral surfaces to the required angles.

The teeth of the cutter are hobbed in a specially adapted Lees-Bradner hobbing machine set up as shown in Fig. 9. The operation is standard, except that in order to hob out the teeth according to angle *B*, Fig. 10, it is necessary to feed the hob a predetermined amount toward the cutter as the cutter is fed past it. This feeding movement is obtained by gearing the work-spindle of the machine to the shaft that actuates the hob slide. The operation requires a special hob, corrected to compensate for the angular cut that it takes, the correction being made by grinding. The cutter is next placed in a lathe for machining the rake angle *D* and cutting recess *E* to provide a clearance for the grinding wheel in a later operation. The cutter is then subjected to the same hardening and tempering treatment as the hobs and permitted to season before being brightened by the mud bath.

### Grinding Operations on the Cutter

The cutters are ground all over. The first step consists of rough-grinding the sides, rake, and hole, and is performed on the B. & S. grinding machine previously referred to, after which it is finish-ground on the same machine. In grinding the hole, the cutter is clamped to the faceplate, after being trued by means of an indicator. For the other grinding operations, it is held on a special arbor and also set up by means of an indicator.

The machine illustrated in Fig. 11 was designed and built especially for grinding the tooth profiles. The cutter *A* is placed on the spindle of a housing which slides along a way on bracket *B* when handle *C* is revolved. Simultaneously with the traversing of the housing, the work-spindle is given a rotary movement by means of a wire held taut between brackets *D* at the front and rear of bracket *B*. This wire is wrapped tightly around the cylindrical surface *E* of the work-spindle, causing the spindle to turn when its housing is moved along bracket *B*. The work-spindle is swiveled in its housing to the angle at which the cutter teeth are machined, which in the case illustrated, is 20 degrees. Graduations on the housing facilitate this setting.

In mounting a cutter on the work-spindle, it is accurately indexed by means of the worm and worm-wheel mechanism at the right-hand end of the machine, to bring the grinding wheel into proper contact with a tooth. This mechanism is also employed to index the cutter for grinding all the teeth. The 192-tooth worm-wheel *F* and a vernier permit indexing of the work to one thirty-thousandths of an inch on a 4-inch diametral pitch cutter. Bracket *B* is mounted on a vertical slide which is adjustable to suit any diameter of cutter.

The first cut is taken on the bottom of the tooth spaces by the flat edge of the wheel which is dressed to a truncated wedge having an included angle equal to the pressure angle of the teeth. When this cut has been taken around the entire cutter, the cutter is indexed slightly to bring one side of a tooth in contact with a side of the truncated wedge. The desired involute is then ground on this side of each tooth as handle *C* is revolved, due to the rotary movement of the work-spindle. The cutter is, of course, indexed one tooth after each traverse of the work-spindle housing. The opposite side of each tooth is next ground by indexing the cutter slightly to bring it in contact with the opposite side of the truncated wedge. In this operation the vertical center line of the grinding wheel passes midway between the portion of the cutter teeth which is relieved 20 degrees.

About 0.0015 inch of stock is removed from the bottoms and sides of the teeth, after which they are again seasoned before finish-grinding. In the latter operation the process is the same as in the preliminary grinding, and about the same amount of stock is removed until the teeth are ground to size. Before the work is removed from the machine, the operator must be able to produce only a bare trace of a spark on each tooth without a noticeable change in the sound of the grinding. The teeth are then checked by means of vernier gear-tooth calipers, and the root diameter is measured. After that a dummy hob is cut from close-grained cast iron and checked. It has been found that the greater the amount of seasoning given a cutter between the different operations, the more satisfactory its service will be.

### Dressing the Wheel for Different Tooth Forms

In the foregoing description of grinding the cutter teeth, it was assumed that the cutter had standard involute teeth of 14½ degrees pressure angle. If the pressure is other than 14½ degrees, bracket *B* is swiveled on its slide to compensate for the difference. In grinding cutters of hobs for gears that are to mesh with gears produced by B. & S. form cutters, or on Fellows gear shapers, the grinding wheel is dressed in a special manner by means of a truing diamond controlled by a mechanism, mounted on the machine at *G*. The wheel must also be dressed similarly to suit special tooth forms.

* * *

## COMMERCIAL STANDARDS FOR TAPS AND DIES

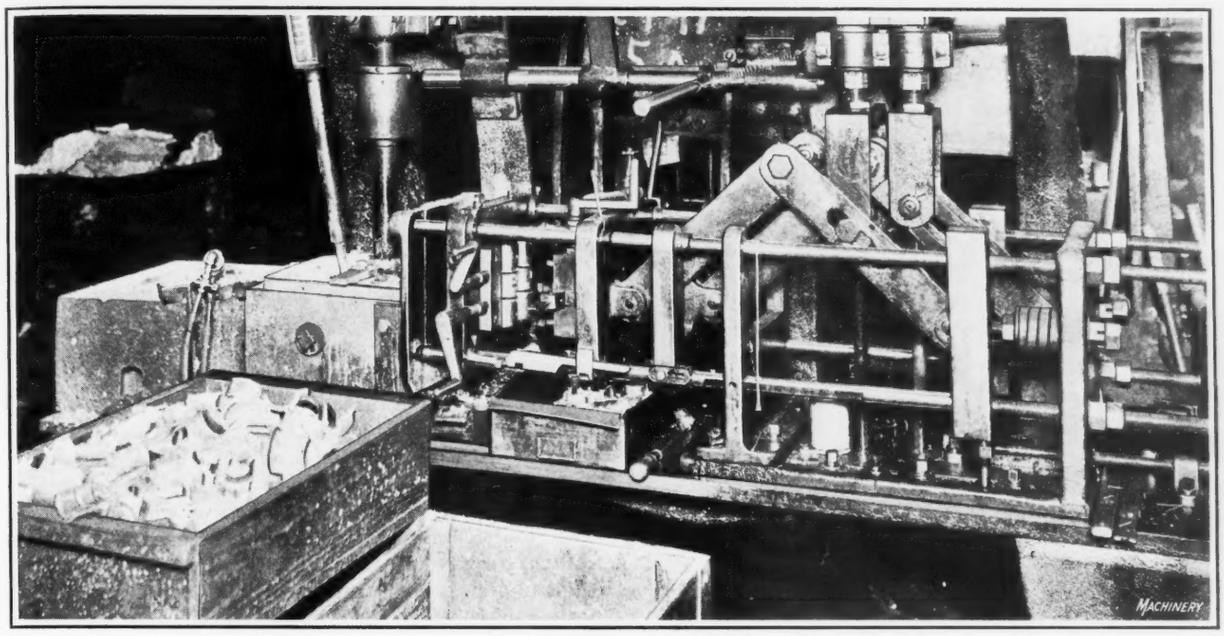
Several years ago the Tap and Die Institute, 116-120 W. 32nd St., New York City, realized that there was a definite demand among users of taps and dies for a greater degree of uniformity in these tools. A comprehensive work of standardization was therefore begun, and as a result a number of standard tables relating to taps, drill sizes, and chamfers on dies have been prepared and adopted. The more important of these standards are incorporated in a pamphlet recently published by the Tap and Die Institute and are presented by the Institute to the trade. Many other standardized dimensions of taps and dies not shown in this pamphlet will be found in the trade catalogues of the various manufacturers of taps and dies. This work of standardization is continually going on and from time to time additional standards will be adopted. The tables in the pamphlet mentioned cover dimensions of hand taps and pipe taps; commercial tolerances for hand taps, pulley taps, machine screw taps, and nut and tapper taps; tap drill sizes; and a table of chamfer on dies. Where tolerances are given, it is understood that these are commercial tolerances for taps, the figures representing the measurements of the taps themselves and not the tapped hole.

* * *

## HARDENING STEEL WITHOUT SCALING

Processes for hardening steel without scaling have had much attention in England during recent years. One of the most successful hardening furnaces that meets these requirements is that made under the Walters patents. In this furnace the work is suspended in a vertical tubular muffle heated by an electric resistance winding of nichrome. The atmosphere in the heating space is coal gas, which is admitted to the lower end of the muffle and escapes slowly through an outlet near the top. The atmosphere therefore is non oxidizing and in fact, slightly reducing. When the work has reached the required temperature, it is dropped straight into a quenching tank without coming in contact with atmospheric oxygen. The result is a surface quite free from pits or scaling. At present the furnace is in use chiefly in tool-rooms and for laboratory purposes, but larger furnaces have been used with great success in the hardening of crankshafts, rolls and other heavy work up to 200 pounds.

# Equipment for Making Die-castings




**Applications of Die-castings—General Principles of Die-casting Machines—Points on the Design of Parts to be Die-cast—First of a Series of Articles**

By A. G. CARMAN, Chief Metallurgist, Franklin Die-Casting Corporation, Syracuse, N. Y.

DIE-CASTINGS are rapidly becoming recognized as a substitute for accurately machined castings or forgings where the requirements placed on the parts are not too severe for the metals that are commercially adapted to the die-casting process. Die-castings may be defined as castings produced by forcing molten metal into metallic dies by a force greater than atmospheric pressure. This definition differentiates them from the class of castings made by the permanent mold process, often referred to as die-castings.

Die-castings are uniform, accurate, and cheap, equal to the product of a skilled workman, but produced by unskilled labor. Their advantage over machined parts is due to the rapidity with which they are produced and the relatively small amount of labor necessary after they are cast to produce a finished piece ready to be assembled. The principal reason that die-castings are not used in much larger quantities than they are is that the attention of engineers has not been called sufficiently to their advantages from a mechanical as well as an economical standpoint.

A brief description of the process by which die-castings are produced, covering the machines and their operation; the dies, their construction and operation; and the metals, their chemical and physical properties, will contribute to a better understanding of the possibilities of die-castings and their application to the requirements of various industries. It is not the intention to give a description of the specially designed automatic machines, which have only a limited field, being confined to smaller castings required in very large quantities, but rather to describe the simpler die-casting machines with the idea of dealing with the general principles of the die-casting process.

### Die-casting Equipment

The die-casting equipment consists of a cast-iron heating pot for the metal, located at a convenient distance from the die-casting machine. The metal in this pot is heated by gas, and is kept slightly above the melting point by regulating the heat and by occasionally adding new metal to take the place of that used in making the castings.

The casting machines proper are of two general types, the plunger type and the compressed air type. The plunger type consists of a cast-iron container for the metal heated by gas. In this container is submerged a rectangular or cylindrical chamber fitted with a plunger. This chamber has two openings, one of which is located in the side or bottom, just at the end of the plunger when it is drawn back preparatory to forcing the metal into the die. This allows enough metal to enter the chamber by gravity to make the casting. When the plunger is forced forward, it closes the opening, and the metal is forced from the chamber through the second opening into the die. The plunger may be actuated by hand, with a long lever, by compressed air, by steam, or by any other suitable power which will supply a heavy, rapid pressure. This type of machine is suitable for casting metals having melting points below 800 or 900 degrees F., and having only slight corrosive action on the cast-iron plunger.

The compressed air type of die-casting machine consists of an air-tight cast-iron chamber for the metal, suitably heated to keep the metal at the desired temperature. This chamber is connected with the die by one opening and with the compressed air line by another. In the latter opening a valve is fitted with a lever for the sudden release of the air into the metal chamber. This valve also permits of a gradual decrease of the pressure on the metal after it has filled the die. This type of machine may be used on metals cast by the plunger type, but is especially suitable for metals that cannot be cast in the plunger type of machine on account of their high melting point or corrosive action on the cast-iron plunger. The air pressure used may vary from 150 to 500 pounds per square inch, depending upon the size and shape of the casting and other conditions under which the casting is made.

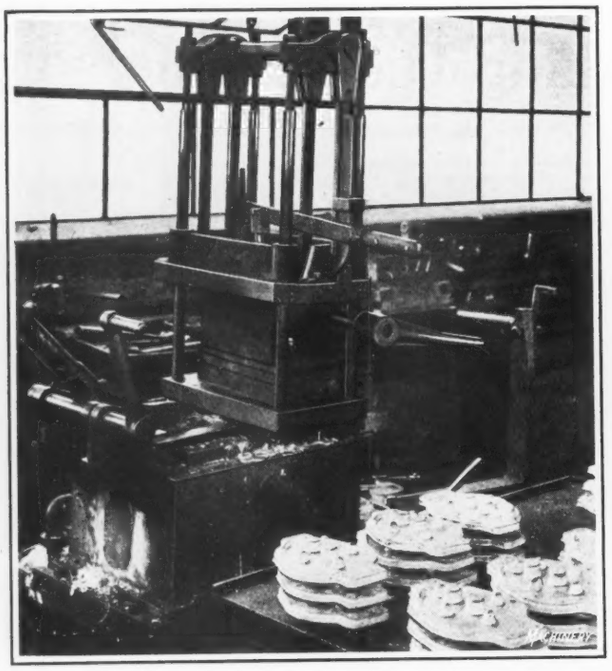


Fig. 1. Plunger Die-casting Machine with Tilting Vise in Vertical Position

The die is attached and held firmly to the pressure chamber by a vise. This consists essentially of two rectangular plates having the two surfaces facing each other held parallel by four legs which hold the lower steel plate rigidly in place but allow the upper cast-iron plate to move backward and forward. The two plates form the supports for the two halves of the die and, by means of a lever and toggle joint attached to the upper plate, serve to lock the two parts of the die securely together while the casting is being formed, and to separate the halves of the die for removing the finished casting. The lower plate has an opening with a nozzle which fits perfectly the nozzle of the pressure chamber for the admission of the metal to the die.

The vises are of two general types, horizontal and tilting. The horizontal type, shown in the heading illustration, is placed at the side of the machine, and by means of four legs allows the plates carrying one half of the die to move only in a horizontal direction for the casting process. The tilting type of vise, illustrated in Figs. 1 and 2, is fastened to the casting machine by a hinge which allows the vise to assume a vertical position (see Fig. 1) while the casting is being formed and a horizontal position (see Fig. 2) while the die is being opened and the casting removed. The horizontal type is especially suitable for automatic power machines, while, in general, the tilting type is more suitable for hand-operated machines.

### Die-casting Dies

The die is by far the most important part of the casting equipment. It requires considerable ability and experience in die construction to so design the location of the gate, cores, vents, and other details, that everything in the construction will add to the rapid production of perfect castings when the die is placed in operation. In addition, skilled machinists, experienced in die construction, are required to carry out the design faithfully in the construction of the die. When it is considered that a single die may cost from $200 to $2000, and that a small error may ruin it, the importance of skilled workmanship will be realized. The dies are made of a high-grade tool steel for the lower melting point alloys, and of a high-grade chrome steel for aluminum alloys.

A die-casting die consists essentially of two parts, held in their proper relation to each other by dowel-pins. In the center of the die is a depression or depressions, an exact duplicate of the casting desired, allowing, of course, for the shrinkage in the metal. Leading to this depression is an inlet through the lower plate for the admission of the metal. The depression may be located wholly in either one of the two parts of the die, or it may be located partly in one and partly in the other. In any case, the parting line must be so located that when the two parts are separated the casting can be easily removed.

### Cores in Die-casting Dies

Some dies have cores *B* (Fig. 2) to form holes or depressions in the castings where they require it. These cores may be stationary, if they are parallel with the direction in which the parts of the die move when being opened, but must be movable when they are not parallel with that direction. Small cores are operated by small levers, and are locked in place by a toggle joint to keep the metal under pressure from forcing them back when the casting is made. Large cores are operated by a rack and pinion, and may be locked in place by dowel-pins whenever the core does not have to be drawn before the die is opened. Still other castings require slides in the die to form special surfaces; these also are usually held in place by dowel-pins while the casting is being made. The die is fastened rigidly to the vise by screws, the upper half *A* to the movable upper plate and the lower half to the lower plate.

Some dies operate best when heated; this is accomplished by means of torches directed on the surface of the die. Others operate best when a cooling system is applied, either by means of a current of air, or by circulating water through channels in the die. There is no rule for determining the conditions under which the dies work best; they must be experimented with when they are placed in operation.

After the casting has been formed, the die opened, and the cores and slides drawn, it is removed from the die by means of ejector-pins. These are small rods fastened to a plate moved by a rack and pinion, by means of handle *C*. The ejector-pins pass through the upper part of the die and extend flush with the surface of the casting depression when pulled back as far as possible. When moved forward by the pinion, they extend into the depression. It is necessary that the pins be so located that the ejection of the casting will not strain the metal, which is still hot.

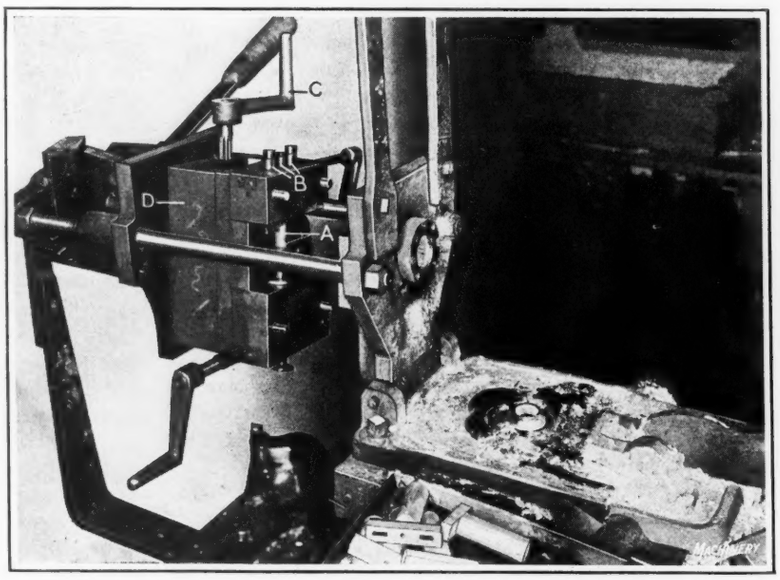



Fig. 2. Plunger Die-casting Machine with Tilting Vise in Horizontal Position

As the metal is forced into the die, it is necessary to provide a means of escape for the air contained in the depression of the die and the passage to the compression chamber; if this is not done, the air will be trapped in the metal and the castings will not be sound. This escape is provided for either by small grooves machined in the parting of the die, or by removing the air from the die by a vacuum pump just prior to the admission of the metal. The former method is the one most commonly used.

### Inspection and Trimming of Die-castings

After the castings leave the foundry, they are taken to the trimming room where they are inspected, the fins removed, holes tapped, and any additional work necessary to prepare the casting for assembly. If castings require polishing, this is also done in this room. The equipment of this room consists of drilling machines, grinding and polishing wheels, band saws, punch presses, lathes, etc. Fig. 3 shows a small portion of the trimming room. From the trimming room the finished castings are taken to the shipping department where they are packed ready for shipment.

Fig. 3. Trimming Room where Die-castings are inspected and the Fins removed

### Designing Parts to be Die-cast

In considering die-cast finished parts, there are certain general points, which if borne in mind by designers, will result in better service, a higher grade of castings and increased production. Under-cuts or recesses in the castings should be avoided. In many cases, it is, of course, possible to use collapsible cores for under-cuts and recesses, but this increases the cost of both the die and the casting process. A slight draft is desirable, especially in the die-casting of aluminum alloys. It is cheaper to cast raised letters than depressed ones, since for the former, it is necessary only to stamp or engrave the letters in the die, while in the latter the surface surrounding the letters must be cut away. However, the use of both kinds of letters is practicable. The sections of die-castings should be as uniform as possible, and small fillets should be added wherever there are sharp corners.

### General Application of Die-castings

Die-castings are not intended to take the place of the parts produced in power presses or automatic machines, or of forgings requiring little machine work; they are intended especially for intricate parts requiring a considerable amount of high-grade machine work. Such castings, in order to be made most profitably, must be required, ready for assembling, in large quantities, at least in lots of thousands, and still better, in 100,000 lots.

As the physical characteristics of the metals for die-castings closely resemble those of cast iron, die-castings readily replace parts usually machined from that metal, and may even supplant brass or steel, with proper changes in design. The low fusion temperature of the die-cast metals also makes it possible to incorporate steel, copper, or brass inserts at points requiring special strength and wearing qualities.

At present, by far the largest number of die-castings are used in the automobile industry, but a great many are also used for electrical equipment. Many miscellaneous parts are employed for household utensils, dental apparatus, phonographs, safety razors, sewing machines, vacuum cleaners, washing machines, and many other devices in general use in the home, office, and factory.

Fig. 4 shows a number of parts, which will give an idea of the diversified purposes for which die-castings are used. *A* is a mounting used on automobiles; *B*, an automobile friction wheel; *C*, a frame for a ticketing machine for department stores; *D*, a frame for dental equipment; *E*, a part for a cream separator; *F*, an accelerator guide for automobiles; *G*, a reel for electrical equipment; *H*, a measuring roll for a cloth-measuring machine; *I*, a jeweller's casting flask; *J*, a stamp case for office equipment apparatus; *K*, a part for dental equipment; *L*, a split gear for knitting machines; *M*, a locking boss for an airplane; and *N* an indexing quadrant for a meat-slicing machine. The parts, *A*, *B*, *D*, *F*, *G*, *K*, and *M* are cast from aluminum-base metal; parts *C*, *I*, *J*, *L*, and *N* from zinc-base metal; and *E* and *H* from tin-base metal.

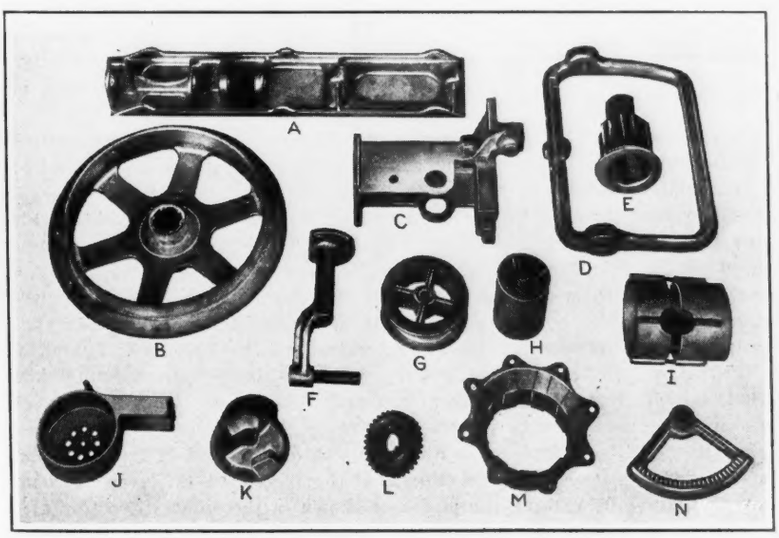



Fig. 4. Examples of Parts made by the Die-casting Process

Subsequent installments of this series of articles will deal with die construction, showing the methods used in the design of dies for many different purposes, including wheels having raised letters, figures, or characters on their periphery, dies for instrument housings, dies for venturi tubes for gas-engine mixing chambers, and dies for door checks. Another article will deal with the metals used in die-casting, giving definite compositions, and will also contain the possible limits for different types of die-castings, and other information of particular value to those who contemplate the use of die-castings in machines or devices of their manufacture. The entire series will present a comprehensive treatise on the subject of die-casting.

# Follow-die for Switch Plates

By GEORGE W. WILDER

SWITCH plates like the one shown at *A*, Fig. 1, are used on the walls and floors of houses to cover electric switches. The brass stock from which this type of plate is made is 0.017 inch thick. As shown, there are four pierced holes in the plate and the outer edges are bent down to give the work a beveled appearance. The work is shown drawn to a larger scale than the die. The two larger holes in plate *A* are for the switch buttons, while the two small holes receive the fastening screws. The plates are given a brush finish, and the corners are required to be stamped sharp on the outside. The various parts of a follow-die used to pierce, stamp, and trim the plates from the strip stock are shown in the sectional view, Fig. 2.

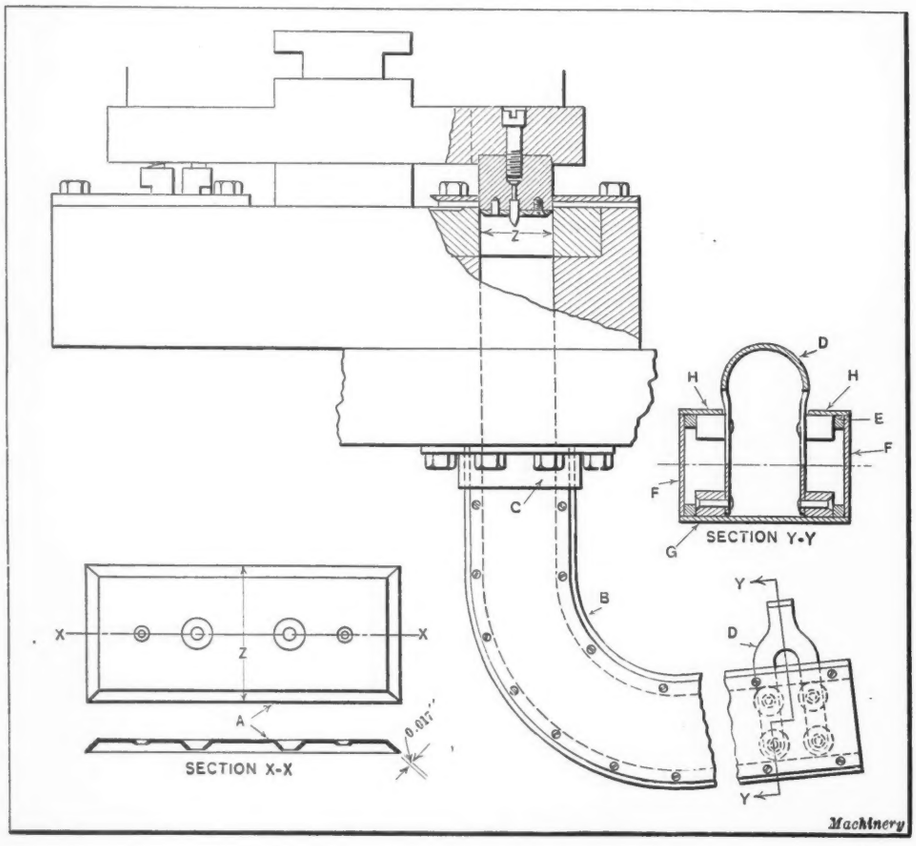



Fig. 1. Follow-die equipped with Stacking Device

The method of production before this die was made consisted of first cutting the metal up and piercing the holes to the proper size and in their correct positions. The plates were next stacked in boxes which were trucked to the stamping room, where they were fed, one at a time, under a drop-hammer, which stamped them to the desired shape. After this operation the plates were again stacked and trucked back to the press room where they were fed by hand, one at a time, into a trimming die. It is important that the faces of the plates should not become dented or nicked, as this would prolong the buffing operation, and if the dent is too deep to be removed by buffing, the plate must be scrapped. It will be seen, therefore, that it was necessary to catch the plates as they came from the trimming die, and stack them again, in order to prevent them from becoming dented.

The follow-die shown in Fig. 2 was so designed that one operator could attend to all operations on the plates except buffing. In order to accomplish this, a catching and stacking device was necessary. The device developed to perform this operation is shown at *B* in Fig. 1, attached to the die. It is commonly referred to by the operators as the "cobbing" chute. The die is of the open sub-press type of construction, and the successive operations pierce, stamp, and trim the work. The stamping operation forces some of the metal below the top surface of the strip stock, thus forming a projection on the under side. It is therefore necessary to arrange for lifting the stamped portion out of the die and providing clearance for the stamped portion when the metal is lowered again in the succeeding position.

The operation is as follows: The metal is started at the left and fed under plate *A*, Fig. 2, until the entering end is flush with the right-hand edge of the plate. The roll feed is then engaged and the press started. As the ram descends, stripper *B*, which supports the piercing punch *C* and receives its tension from springs *D* (only one of which is shown), engages the metal between it and the spring pad *E*, which, in turn, receives its tension from springs *F*. The stock is then carried down into contact with the top of die *G*, where it is pierced by punch *C*. The scrap passes out through a hole in the die-block. As the ram ascends, stripper *B* strips the metal from the piercing punch *C*, and spring pad *E* lifts the metal up high enough so that it will clear the forming die *H*.

For clearness the smaller punch which pierces the screw hole is not shown, but it should be borne in mind that all four piercing punches are in line and held in the same manner as punch *C*; Fig. 2 shows only a cross-section taken through one of the punches.

The strip is again fed forward, and on the next stroke the metal is engaged between the forming pad *J* and the forming punch *K*. When in this position, the stock is located by the forming pegs at the center of pad *J*, which act as pilots. All four forming pegs are held in plate *M* in the same manner. The forming pad *J* is supported by three springs *N* so that the metal, when it is drawn over the beveled edge of the die *H*, will have no tendency to wrinkle or pull. The stock is also kept from wrinkling by the spring pad *P*, which holds the surrounding stock between its lower face and the die *H*. This pad is held in place by screws *Q* and receives its tension from springs *R*.

At first, much difficulty was experienced in forming sharp corners on the outside of the plate, but this was overcome by making the punch as shown in the enlarged section at *S*. The ridge around the edge of the punch was ground from 0.004 to 0.005 inch higher than the major face of the punch,

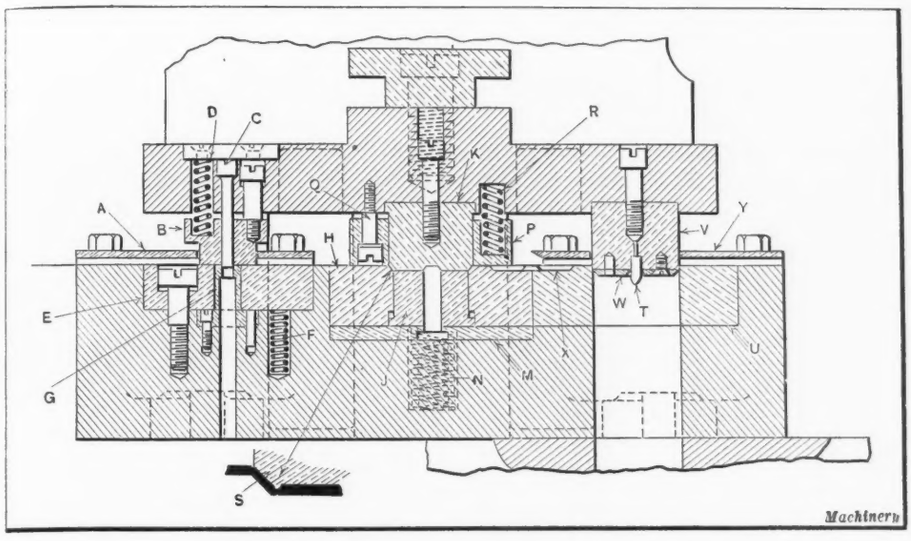



Fig. 2. Sectional View of the Follow-die for piercing, forming and trimming Switch Plates

and about 0.040 to 0.050 inch in width. This ridge forces the metal out so that it fills in the space in the die (and sometimes throws a slight "fin," which is removed in the buffing operation), making a sharp corner where otherwise there would be a round corner having a radius equal to the thickness of the metal. As the ram ascends, the springs *N* force the pad *J* up, which, in turn, lifts the formed plate up so that it can be fed across the die *H* without catching on the corners of the die recess. The pad *J* bottoms on the steel plate *M*, which receives the extreme pressure at the end of the downward stroke.

The metal is again fed forward, so that at the third stroke of the press the holes pierced in the first position are in line with pilots *T*. The plate is trimmed as the punch *V* enters the die *U*. The punch *V* has a formed plate *W* of soft steel fastened to it which fits the work. This form is removed when the punch is being ground. As the distance between the centers of the piercing and forming dies is equal to two blanks plus the bridging, it was necessary to cut a clearance at *X* to receive the impression made in the stock by punch *K*. As the ram ascends, the metal is stripped from the punch by the stripper plate *Y*, which is beveled at its front end to eliminate any tendency for the metal to catch or stick when being fed forward.

The plate, when trimmed, passes down through the die bed into the cobbing chute *B*, Fig. 1, which is fastened to the bolster plate by four angle-irons *C*. The cobbing is started by placing friction spring *D* up as far as it will go in chute *B* and filling the remaining space between it and the die with plates. Then when a plate is trimmed, it is forced through the die, and presses the friction spring *D* down a distance approximately equal to the thickness of the plate. The chute is bent to an angle of slightly less than 90 degrees, and after the plates are cobbed beyond this bend, the friction spring may be removed, and the plates taken out in small stacks and put in boxes near the operator.

The sectional view of chute *B* shows the friction spring *D* and the rolls that ride inside the chute. The chute frame is built around four square steel pieces *E*. It is closed in on three sides by the plates *F* and *G*, and is partially closed at the top by plate *H*. The chute has a support at the extreme end, which is fastened to the floor. The 200-ton Bliss press on which this follow die and stacking device are used is run at a speed of 30 revolutions per minute. The coiled stock is fed to the press by a single-roll feed, and the scrap is wound on a reel. The press thus equipped turns out and stacks one plate at each stroke, or thirty plates per minute. This die enabled the production to be greatly increased, and the three operations were performed by one operator.

* * *

## RESULTS OBTAINED BY MACHINE-LAPPING

A number of interesting comparisons between ground, hand-lapped, and machine-lapped surfaces were shown in April, 1922, MACHINERY. The accompanying illustrations show other examples of similar work. Fig. 1 shows a cylindrical ground surface of very good quality, magnified one hundred times. Fig. 2 shows very good hand-lapping on a similar cylindrical surface; and Fig. 3 shows high-grade machine-lapping on the same class of work. It will be seen that in the hand-lapping the scratches run in all directions, while in the machine-lapped surface the marks or scratches run practically in one direction only. Several concerns have now developed means for doing machine-lapping satisfactorily, and consider the results obtained by this means in gage work to be superior to hand-lapping.

* * *

It has been found of advantage in thermit welding to cut a channel or trough in the top surface of the mold connecting the pouring gate and the top of the riser. The purpose of this channel is to cause the first slag that overflows on the top of the mold to drain quickly into the riser while the metal is still very liquid. This has a tendency to equalize the pressure on the pouring gate and the riser.

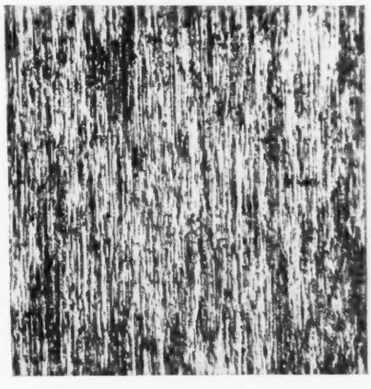


Fig. 1. Ground Surface; Magnification, 100

Fig. 2. Hand-lapped Surface; Same Magnification

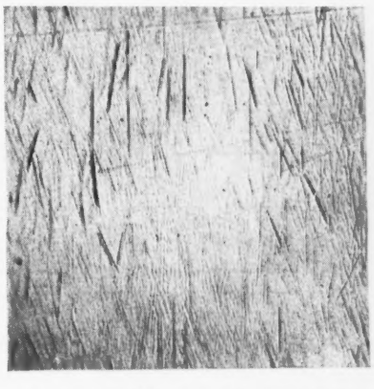
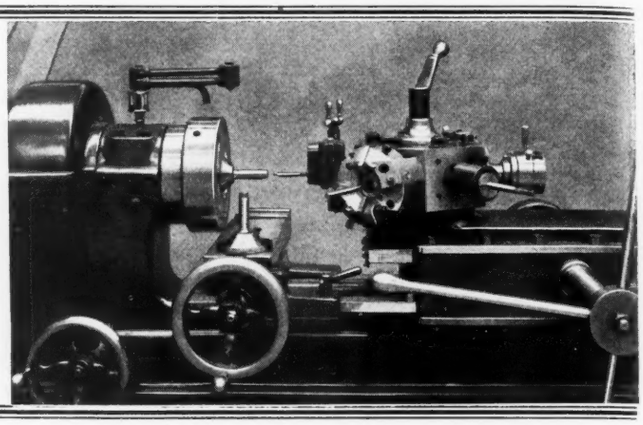


Fig. 3. Machine-lapped Surface; Same Magnification

# Using the Turret Lathe for Small Lots

**Examples Showing How Small Quantities of Bar Stock Parts can be Economically Produced on the Turret Lathe**

By ALBERT A. DOWD, President
and
FRANK W. CURTIS, Chief Engineer
Dowd Engineering Co., New York



IN the average shop, when business is dull and the factory is not engaged in high-production work but largely on small orders of different kinds, engine lathes are generally found busy and turret lathes idle. If the foreman is asked the reason for this, he will probably say, "Well, there are only a few pieces of each kind to be made, and it would take too long to set up a turret lathe for the job." This statement is based on a misconception, and it is the writer's belief that many manufacturers sustain losses because of this mistaken attitude. As a matter of fact, the turret lathe can be used economically on short jobs.

When turret lathes are used on small orders, the work is quite different from production work, although many of the same tools are used. The economies effected are dependent to a great extent upon the rapidity of the operator in setting up the machine. A man who is finicky in his methods will not prove successful on work of this kind, although he may be a good operator on high-production work. He must know the machine thoroughly and understand how to get the most out of it, not only by using proper speeds and feeds, but also by the selection of suitable tooling equipment.

### Work that could be Economically Handled in Small Lots

In order to illustrate the adaptability of a turret lathe for small jobs, a few examples of bar work will be presented. The work at *A* in Fig. 1 is a shaft which is to be finished all over to the dimensions specified. None of the tolerances are extremely close, and a good commercial job is all that is necessary. Ten pieces are required, and for such a job the average manufacturer who has not considered the problem carefully would say that the best method of handling it would be on an engine lathe. In the second example a half dozen special bolts, such as shown at *B*, are to be turned and threaded from hexagonal stock. The sleeve *C* is another part which would ordinarily be considered more suitable for an engine lathe when only a few parts are to be made. Twelve of these pieces are wanted. They are to be finished all over, but a high degree of accuracy is not required. Only three parts *D* are wanted and these are all to be held rather close to size. The special collar shown at *E* is to be made of bronze and finished all over. Twelve of these pieces also are wanted.

### Procedure in Performing the Operations on Engine Lathes

If example *A* were machined on an engine lathe, it would doubtless first be centered at both ends and then held on centers while the various cylindrical surfaces and shoulders were turned one after the other, using a micrometer to establish the various sizes. Each piece would be handled separately and measured separately, although the diameters could be approximated very closely by means of the micrometer dial on the cross-slide. The shoulder distances would need to be measured or else it would be necessary to provide some special arrangement on the ways of the lathe to determine the proper distance to the various shoulders.

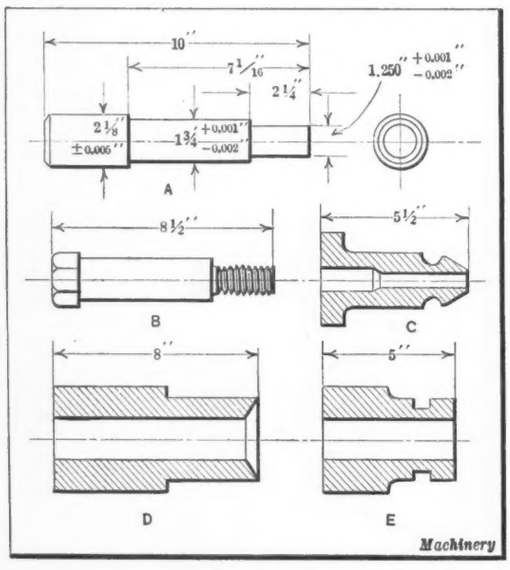



Fig. 1. Examples of Parts made from Bar Stock

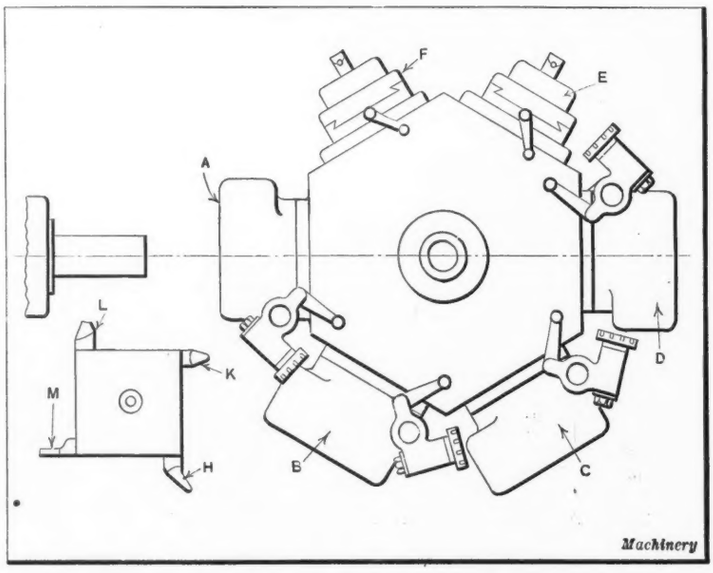



Fig. 2. Turret Lathe Tooling adapted for making a Variety of Parts

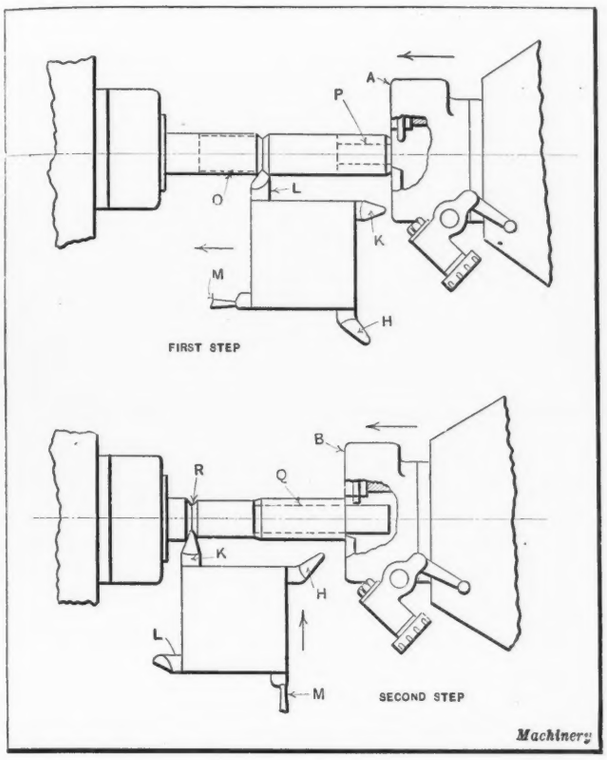



Fig. 3. First and Second Steps in machining Part A, Fig. 1

With example *B*, the work would be centered, as in the preceding case, the various surfaces turned and the end threaded by chasing it with a single-point threading tool. Example *C* might be held in chuck jaws to permit the two holes to be drilled and the outside of the flange turned in the first operation. For the second operation, the work might be held on an arbor, in soft chuck jaws, bored out to the diameter of the flange, or perhaps a chamfer might be machined in the outer end of the holes to allow it to be held on centers and driven by a dog. The angular part at the small end could be turned by a flat forming tool, while the groove on the outside of the piece could be produced by a round-nose tool.

Part *D* would be held in chuck jaws, and the hole bored, reamed, and chamfered at one end, as shown. The work could then be placed on an arbor, and the outside turned and faced. Work *E* would be handled in a somewhat similar manner, being held by the outside while the hole was drilled and reamed, and on an arbor in a second operation to finish the outside diameter and face the ends. If only one piece were needed of any of these parts, the engine lathe would, of course, be most suitable for its manufacture, but when several parts are needed a turret lathe is preferable. It is possible to set up a group of more or less standard tools on the turret and cross-slide toolpost of certain types of turret lathes in such a way that a considerable variety of work can be handled without making any radical changes in the tooling. In the following, tooling equipments adaptable to turret lathes built by the Warner & Swasey Co., Cleveland, Ohio, will be considered.

### Typical Turret Lay-out for Jobbing Work

Fig. 2 shows the turret and square toolpost of the cross-slide equipped with a number of standard tools and several special ones. This lay-out is not suitable for all kinds of work, but it has a considerable range for certain varieties of bar work. When work is made from bar stock, the collet mechanism, of course, is used, jaws of suitable size being placed in the chuck according to the diameter of the work. The turret is equipped with four universal turning tools *A*, *B*, *C*, and *D*, and two slide-tools *E* and *F*. The square toolpost of the cross-slide carries a rough-turning tool *H*, double chamfering tool *K*, finish-turning tool *L*, and parting tool *M*. The cross-slide tools can be easily replaced by others of different form when the nature of the work requires it. The universal turning tools can be used for turning all cylindrical surfaces requiring considerable accuracy, while other surfaces of not such great importance can be machined by some of the cross-slide tools. In boring holes, cutting recesses, or facing behind shoulders, the slide-tools *E* and *F* will be found useful.

### Setting up the Machine

The manner of arranging a machine provided with the tooling shown in Fig. 2 for machining part *A*, Fig. 1, will now be considered. A set of collet jaws of the right diameter is selected, and a bar of stock placed in the jaws, but the latter are not closed tightly on it. The turret is then brought up and the stock pushed back into the collet jaws until only a sufficient length extends. The collet is next locked, and the turret stop set so that other pieces will be made to the same length. The machine is now ready to make the first piece. The operator then brings up the turret, as shown in the first step in Fig. 3, and adjusts the universal turning tool *A* to turn surface *P*, leaving a small amount of stock for the finishing operation. This step is a "cut-and-try" proposition, but after the size has once been determined upon, no further setting is required for the turning tool.

After the distance to the shoulder has been measured and found to be correct, the turret stop is set so that the same surface on other pieces will be cut to the same length. The next step is to bring up the cross-slide toolpost, and by using tool *L*, feed into the work and then longitudinally toward the left along surface *O*. This step must also be done carefully until the correct diameter has been cut, after which the same diameter can be maintained on other work by reading the micrometer dial of the cross-slide. When the correct length has been determined, the longitudinal stop for the turret can be set. Tools *K*, *H*, and *M* are idle in this step. The tools in succeeding illustrations are designated by the same reference letters as are used for the same tools in Fig. 2.

For the second step on this piece, another universal turner *B* is brought up to machine the second cylindrical surface

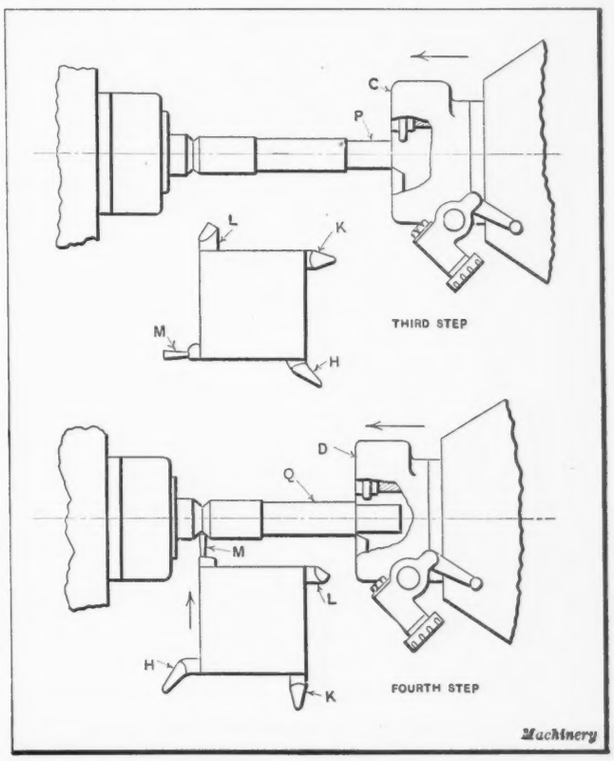



Fig. 4. Two Final Steps in machining Part A, Fig. 1

$Q$ and the procedure followed in setting the tools for surface $P$ is repeated. The cross-slide toolpost is then indexed to bring into use the chamfering tool $K$, which cuts a groove $R$ at the point where the work is to be cut off, and at the same time chamfers the end of the piece and the end of the stock. The third step consists of finishing the surface $P$, as shown in Fig. 4, the universal turning tool $C$ being utilized and the cross-slide toolpost remaining idle.

The fourth step consists of finish-turning surface $Q$ with the universal turning tool $D$, after which parting tool $M$ can be set for cutting off the work. All the tools should be adjusted and the various stops set before the bar is cut off. The operator can then immediately go ahead and produce the number of pieces required, no further setting of tools being necessary, as the various stops and micrometer dials permit duplication of the work without difficulty.

### Turning and Threading a Special Bolt

For the manufacture of bolt $B$, Fig. 1, the tooling equipment in Fig. 2 can again be used, with the addition of a die-head for cutting the thread. Fig. 5 illustrates the tool used in the first and second steps. The collet jaws must also be changed to hold the hexagonal stock from which the work is to be made. In the first step, the turret stop is set to determine the length of work, and after this the universal turning tool $A$ is brought up to turn the right-hand end of the part to the outside diameter of the thread. Tool $K$ is next set to chamfer the opposite end of the part and the end of the stock, as indicated. The second step, which consists of turning the bolt body, is accomplished by means of turning tool $B$.

Fig. 6 shows the third step, which consists of cutting the threads with a self-opening die-head $X$ placed on the turret, after removing slide-tool $E$, Fig. 2. In setting the stop for the "run" of the die, much depends upon the type of die-head used. If it is designed for outside tripping, it requires a special stop set to operate at the proper time, but if it is of the pull-off type, it is only necessary to set the turret stop so that it will function at the proper distance from the end of the part being threaded. The parting tool $M$, Fig. 6, is used to cut off the stock after the work has been completed, but this cut may be started while the die-head is in operation or even a trifle before in some cases. It can readily be seen that work of this nature can be performed in much less time than on an engine lathe, even when only a small number of parts are to be made.

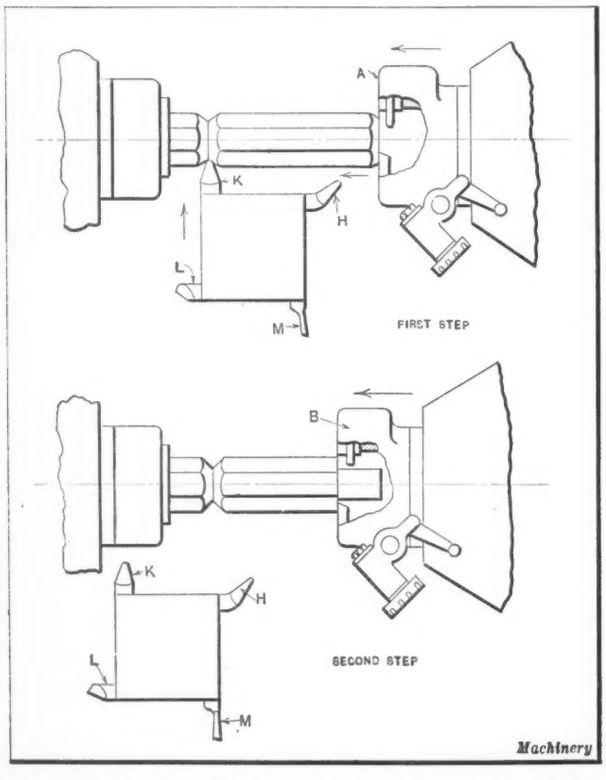



Fig. 5. Tools employed in the First and Second Steps on a Special Bolt

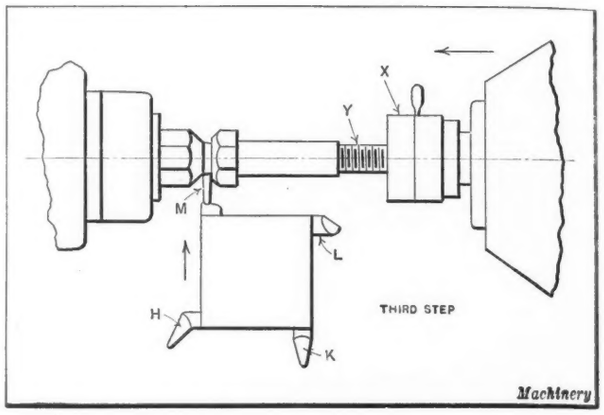



Fig. 6. Cutting the Threads on the Bolt and severing it from the Stock

### Method of Handling a Piece of Formed Work

It might appear at first glance that the work shown at $C$ in Fig. 1 could not be handled economically in small lots on a turret lathe. However, a careful examination of the tool lay-outs shown in Figs. 7, 8, and 9 will make it evident that only small changes are necessary in the original set-up to handle this piece. Fig. 7 shows the first and second steps. In the first step, the work is held in a collet of suitable size, and the universal turning tool $A$ is set to turn the body. A considerable amount of stock is removed, but as the tolerances on the piece are not exacting, a single cut is sufficient to produce the piece within the specified limits.

It would be possible to turn the flange in conjunction with the body, by making certain changes in the set-up of the tooling on the cross-slide, but by using a universal turning tool in a later step, the arrangement of the tools on the cross-slide is not disturbed so much. Tools $L$ and $M$ remain in the cross-slide turret for this work, the same as in the previous toolings, but two tools $V$ and $W$ are substituted for $K$ and $H$. Tool $V$ is used in the second step to cut the groove, the diameter of the work at this point being ascertained by reading the micrometer dial on the cross-slide.

It will be seen that the work is unsupported, and there is therefore a possibility of chatter in taking this grooving cut. In all probability, it would be necessary to feed the cross-slide turret carefully by hand, in order to avoid this contingency, and if it were found that vibration caused trouble, the groove should be finished in another operation on an engine lathe after the holes had been drilled. The work could then be supported on an arbor. The turret is not used in this step, although universal turner $B$ can be indexed and brought into position for a succeeding cut.

Fig. 8 shows the third and fourth steps on the same piece. The third step consists of taking a simple cut with tool $W$ in the cross-slide turret to form the tapered end of the work. The cross-slide can be fed in the direction indicated by the arrow, but it may be found better to feed it longitudinally to reduce the chance of chatter. This step should not be accomplished by power feed, but rather by hand, using the longitudinal stop of the machine as well as the micrometer dial on the cross-slide to determine the proper sizes. In the fourth step, the universal turning tool $B$ is brought up and the flange turned, only one cut being required, as but a small amount of stock is to be removed. For this operation, it is necessary to move the cross-slide along the ways of the machine so that it will not interfere with the turret movement.

The final step on this piece is shown in Fig. 9. Little comment is needed on this operation, because tool $M$ is simply used for cutting off the work, the universal turning

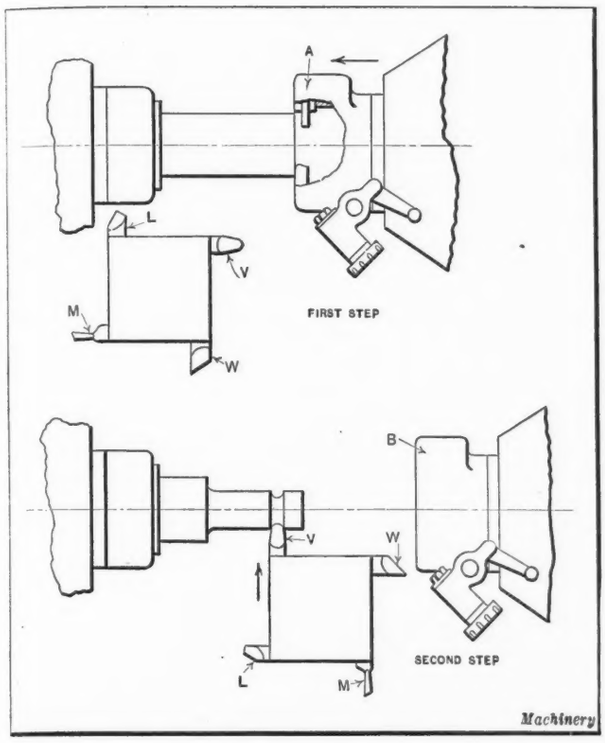



Fig. 7. Turning and Grooving Steps on the Part illustrated at C, Fig. 1

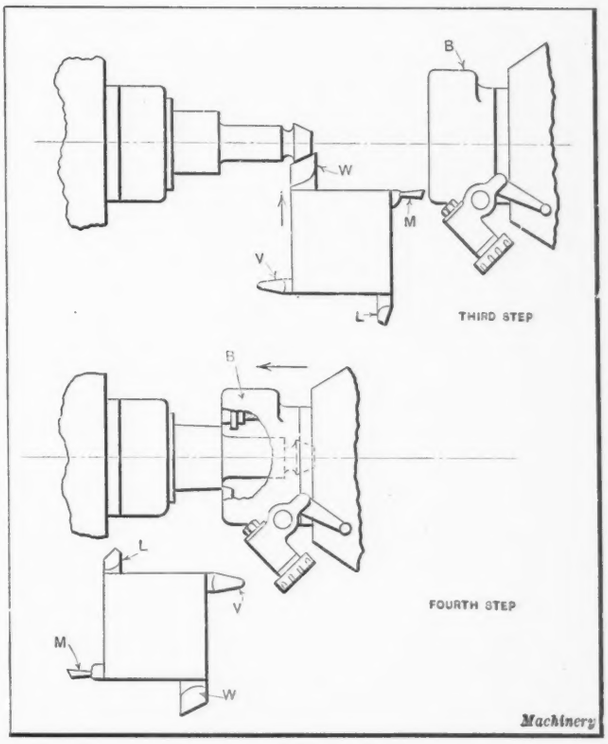



Fig. 8. Tapering the Front End of the Part and turning the Flange

tool *B* being run back out of the way. It should be noted that only two turret tools *A* and *B* are used for machining this piece, so little turret indexing is required during the five steps. It is also possible to use the turret lathe for drilling the holes by substituting collet jaws of the proper size to hold the body of the work and by using two drill-holders in the turret and a reamer for the small hole.

### Machining a Bronze Collar

Figs. 10, 11, and 12 illustrate the method followed in machining the bronze collar *E*, Fig. 1. This piece is also machined from bar stock in a single operation, although a final operation on an engine lathe is necessary to make the outside surfaces concentric with the hole. Nevertheless, the piece can be produced by roughing on a turret lathe and finishing on an engine lathe in considerably less time than would be required for machining complete on an engine lathe. The work is held for this operation in the usual manner in collet jaws. In the first step, illustrated in Fig. 10, the universal turning tool *A* is utilized for rough-turning to the small outside diameter. Tool *X* is substituted on the cross-slide for the regular tool *H*, but this tool is not employed until the fourth step.

The universal turning tool *B* is used in the second step, as shown in Fig. 11, to finish the large cylindrical portion of the work. The cross-slide is moved along the ways of the machine a sufficient distance not to interfere with the movement of the turret. For the last three steps on this piece, it is necessary to remove tools *D*, *E*, and *F*, Fig. 2, from the turret and substitute standard drill-holders. This change in setting takes only a short time. In the third step, drill-holder *R* is equipped with a short stubby drill, as shown in the illustration, which is used as a starting tool for the hole which is to be drilled in the next step. It is advisable to have this drill as short as possible in order to obtain accuracy in starting the hole.

After this drill has been removed from the work, the turret is indexed to bring holder *U* in position, as shown in Fig. 12, and a long drill in this holder completes the drilling of the hole. While this drilling is in process, the special tool *X* is used to cut the annular groove, the setting for the cross-slide turret being determined by the adjustment of stops and the micrometer dials. There is an advantage in using the grooving tool while the drilling is in process, as the drill assists in supporting the work and so reduces the likelihood of chatter.

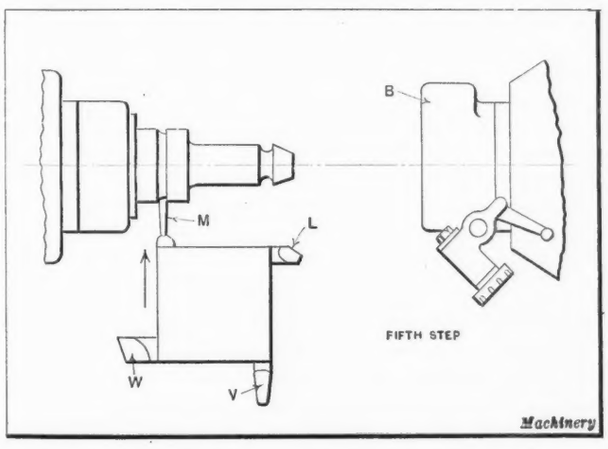



Fig. 9. Cutting off the Part from the Stock by using Tool M in the Square Turret

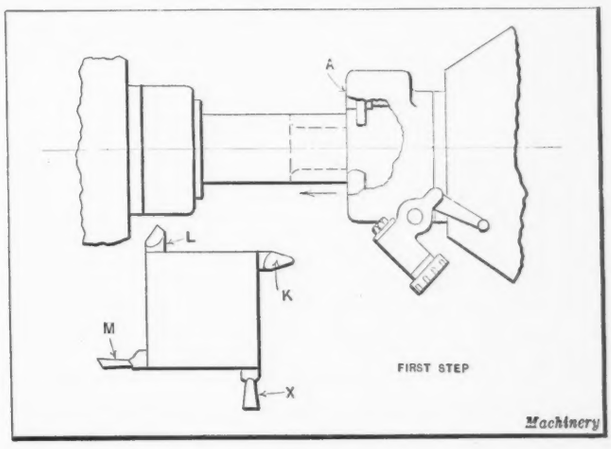



Fig. 10. Preliminary Turning Step on the Bronze Collar illustrated at E, Fig. 1

For the fifth step, the drill-holder *V* is equipped with a floating holder *W* which carries a reamer. The turret is fed by hand while reaming the hole. As it is possible that the hole may be slightly eccentric, it is necessary to place the work on an arbor and refinish the outside diameter on an engine lathe, as previously mentioned, in order to make the outside surfaces true with the hole. Only a very small amount of stock will need to be removed. Parting tool *M* is used to cut off the work while the reaming step is in progress.

No lay-out of tools has been shown for part *D*, Fig. 1, as this part is simple and does not require any different tooling from that shown in Fig. 2. It might be necessary, however, to have a final finishing of the cylindrical surfaces due to a slight eccentricity that may develop during the process of machining. The part should be supported on an arbor for this operation. If the hole were of large diameter, it might be possible to drill it first and then bore it, using a boring-bar on either slide-tool *E* or *F* and thus generating a true hole for the floating reamer to follow. In this case a final operation might not be required.

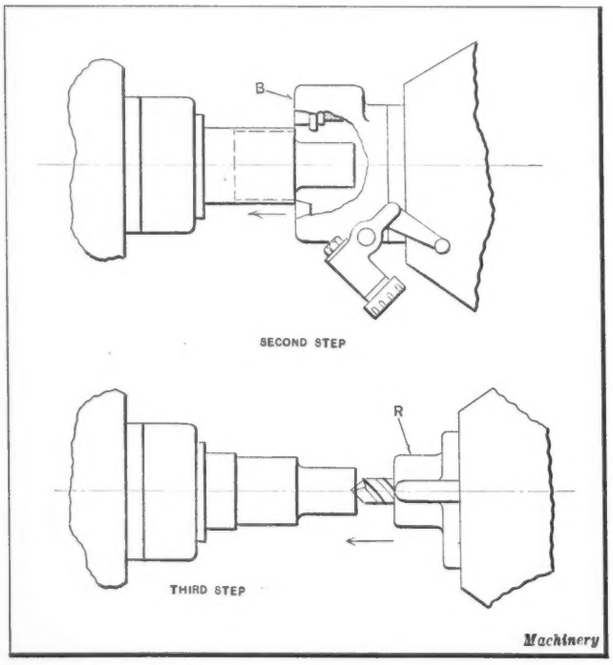



Fig. 11. The Second Turning Step and the Beginning of the Drilling Operation

It will be apparent that many pieces other than those dealt with can be handled equally well with the same kind of equipment, although slight changes in the set-up of the turret and cross-slide toolpost may sometimes be found advantageous. A little care and judgment on the part of the turret lathe operator in selecting the tools will enable him to machine a great deal of work ordinarily manufactured on the engine lathe.

* * *

## PLASTIC WOOD

A recent number of *Engineering* states that plastic wood is a name given to a new material manufactured by a British concern. This preparation, which is made from very fine wood meal having the consistency of soft putty, is supplied ready for use. It is expected that this material will become valuable in patternmaking and molding, for it can be used in wood patterns for various purposes, such as for fillets. It adheres firmly to wood, and can be applied and smoothed down with the hand or a tool. It will set quite hard, but can be cut with an ordinary tool like wood and turned in the lathe or finished with sandpaper. The hardened material is not brittle, and nails can be driven firmly into it without causing cracks.

## THE GAGE STEEL COMMITTEE

The problem of length changes in master gages, and of wear in working gages is of great importance to all users of gages, while that of dimensional changes in hardening and of machineability are serious problems with the manufacturers of thread gages. In appreciation of this situation, Major J. O. Johnson, chief of the Gage Section of the Army Ordnance, has enlisted the interest of the several groups concerned with these problems, and his efforts have culminated in the formation of a committee on which manufacturers of gages, users of gages, manufacturers of steel, and the Bureau of Standards, are represented. This committee, of which B. H. Blood of the Pratt & Whitney Co. is chairman, and H. W. Bearce of the Bureau of Standards, secretary, has outlined a program of experimental work which is briefly (1) to develop a quick wear test for gage steels; (2) to determine the behavior of a selected series of commercial steels in service; and (3) to determine the best heat-treatment for such steels. As this program calls for considerable experimental work, the Bureau of Standards

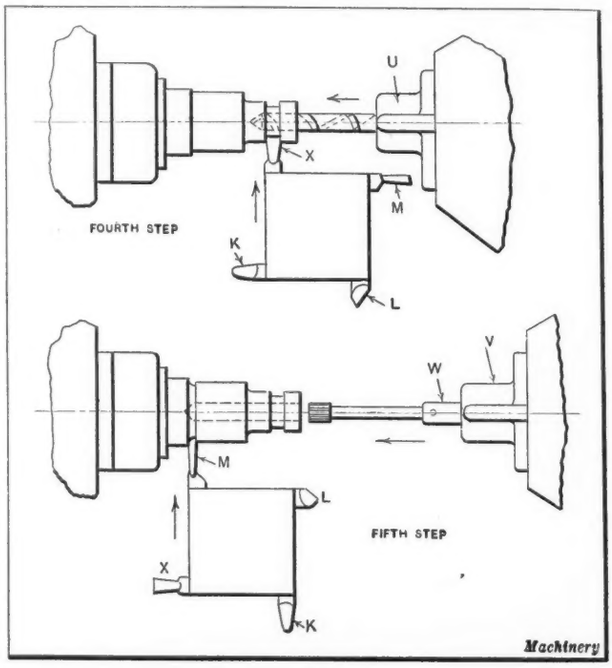



Fig. 12. Completing the Drilling of the Hole, grooving, reaming and cutting off

has assigned an investigator, H. Scott, to give full time to these problems. The financial requirements are met in part by a fund of $5000 transferred to the Bureau by the War Department and an equivalent sum given by the Bureau. The steels for this work are being supplied free of charge by steel manufacturers, and the mechanical work and heat-treatment by the gage manufacturers; the Bureau of Standards is conducting length measurements, quick wear tests and laboratory investigations, and it is expected that the users of gages will undertake the service tests.

* * *

## EXPOSITION OF ENGINEERING APPARATUS

A national exposition of power and mechanical engineering apparatus will be held at the Grand Central Palace, New York City, beginning December 7, and extending until December 13. It follows the annual meetings of the American Society of Mechanical Engineers, and the American Society of Refrigerating Engineers. The exposition will emphasize the engineering phases of the problems involved in the economical uses of fuel, and a more effective generation and utilization of power. The educational value of such an exposition should be considerable.

## METRIC GRADUATIONS ON MACHINE TOOLS FOR FRANCE

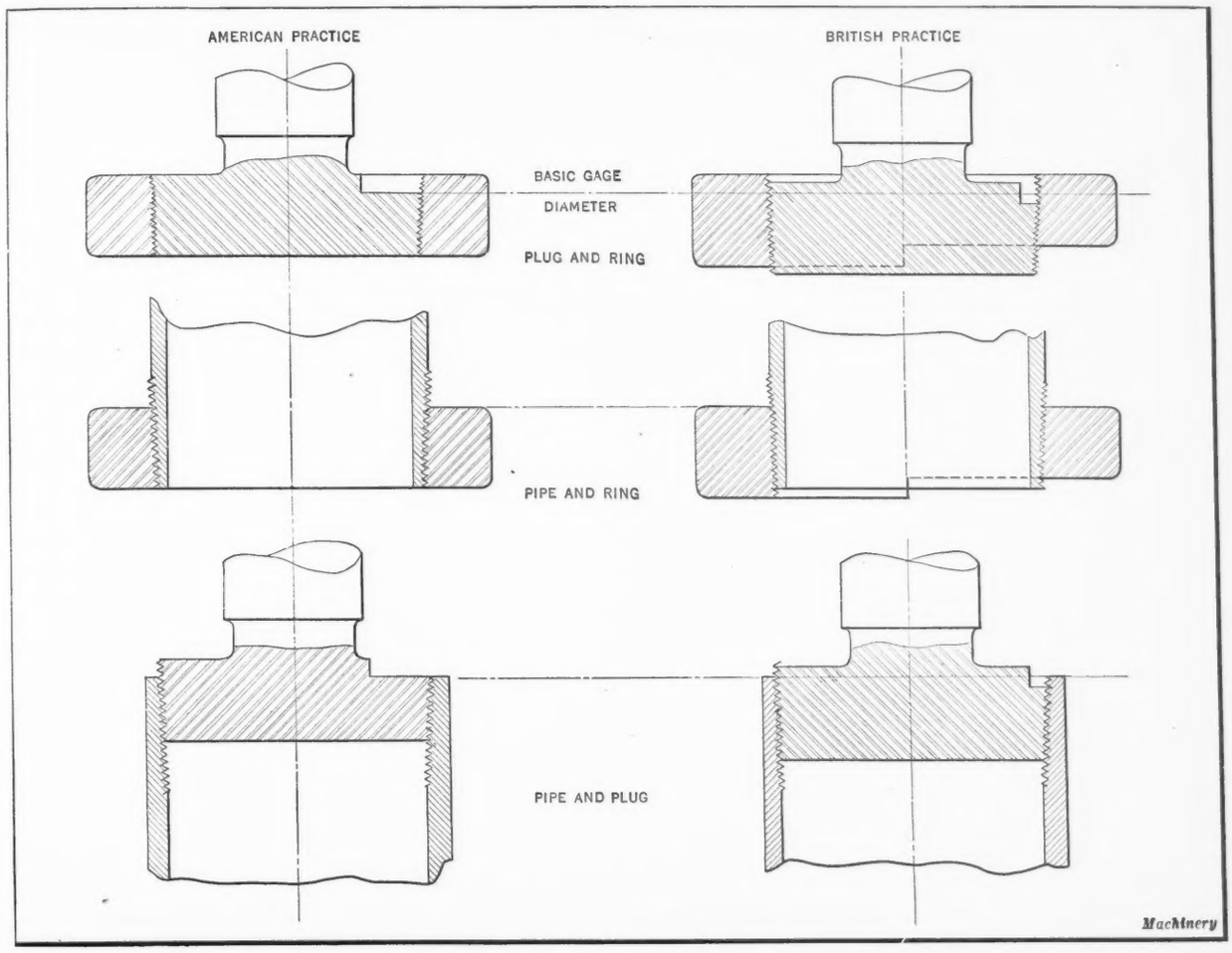
A correspondent in France calls attention to the value of having all graduations on American machine tools sold in France made in the metric measure. Many buyers hesitate to purchase American machine tools of certain types because of the difficulties met with by the workmen in certain lines of work. This is particularly true of lathes and milling machines having graduated collars on carriage or table feed-screws. These collars are usually graduated in thousandths of an inch. It would, of course, be much easier for a French user if these collars were graduated in, say, hundredths of millimeters. In the case of lathes, either metric lead-screws should be supplied, or a translating gear having 127 teeth should always be furnished on any machine sold to France. Graduations in inches, and lead-screws with English pitches, which make it difficult to cut metric threads, without doubt act as a brake on the selling of American machine tools in the countries where the metric system is universally used in machine building shops.

Another thing that must not be forgotten is that previous to 1914, about 65 per cent of the machine tools imported into France came from Germany, and only 10 per cent from America or England. The German manufacturer was well versed in the requirements of the French market, and knew how to introduce his products. Numerous salesmen, generally of French nationality, covered the entire country. Liberal terms of sale were offered by German manufacturers. Thus firms with small capital became strong supporters of the German product. After the war there was at first strong opposition to the buying of German machines, but gradually a large number were imported and sold, and doubtless many of Germany's old customers in France have been regained.

## BRITISH STANDARD PIPE THREAD AND GAGE DIMENSIONS

By CHARLES G. SPICE
Research Engineer, Pratt & Whitney Co., Hartford, Conn.

In November, 1909, the British Engineering Standards Committee, supported by various British engineering institutes, published Report No. 21 on British standard pipe threads for iron and steel pipes and tubes. This report also gave a schedule of sizes in which the dimensions given for the various depths of thread were only approximately specified. A recent report issued by the British National Physical Laboratory contains tables in which these approximate dimensions have been corrected to bring the thread to the true Whitworth form, the tables covering all ordinary sizes. Table 1 is based on the original report of 1909, but is corrected throughout to suit the more recent report mentioned. It might be well to call attention to the fact that the British Whitworth standard pipe thread is perpendicular to the conical surface, whereas the Briggs or American standard pipe thread is perpendicular to the axis of the cone.




Diagrams illustrating the Differences between the American and British Methods of gaging British Standard Taper Pipe Threads

At present there are two practices employed for gaging Whitworth taper pipe threads—American and British. This condition is due to the fact that inspectors in America are accustomed to gaging the work as they do American standard taper pipe threads, and therefore consider the tolerances in turns, or fractions of a turn, plus or minus from the basic. The American practice, when the plug gage and its templet are screwed together, is to have the plug flush at the top and bottom with a thick ring, or the bottom and the basic gage diameter notch flush with a thin ring. Furthermore, when using the ring to gage work, the end of the work must not be above or below the small end of the ring a greater amount than the specified toler-

ance, and likewise, when using a plug to gage a fitting, the notch must not be above or below the end of the fitting a greater amount than the tolerance specified.

With the British practice, however, the plug and ring ends are not flush when the two are screwed together. The plug protrudes slightly beyond the small end of the ring, and the top is a like amount below the face at the large end. Also, British plug and ring gages are each provided with two steps, and the work, either a pipe or fitting as the case may be, must come between the limits indicated by the steps. The British practice is to express the tolerance as the length of thread in inches, whereas with American practice the tolerance is expressed as "turns plus or minus from basic." The accompanying illustration shows diagrammatically the various differences between the two gaging practices. A point worthy of notice, however, is that the final result obtained with the product is identical no matter which practice is followed; this is due to the fact that the location of the basic gage diameter is the same in either case in so far as the end of the pipe itself is concerned.

In the original report of the British Engineering Standards Committee, it is stated that a plain taper ring gage and a threaded plug gage were used. Thus the outside of the pipe only was gaged and not the threads. The report of the National Physical Laboratory (1921) indicates the adoption of the American method of gaging—that is, with threaded ring and plug gages. The actual difference in the dimensions of gages made to each system are presented in Table 2. The Pratt & Whitney Co. has been making gages according to the American system for a number of years, and these have been acceptable to the British authorities.

TABLE 1. BRITISH WHITWORTH TAPER PIPE THREAD DIMENSIONS

| Nominal Pipe Size | Outside Diameter of Pipe | Basic Outside Diameter of Gage | Threads per Inch | Single Depth of Thread | Minimum Thread Length on Pipe End | Distance of Basic Gage Diameter from Pipe End | | | | No. of Pipe Turns in Hand Fitting (Approx.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | American and British (Nominal) | British Practice Limits | | American Practice Max. and Min. Limits in No. of Turns from Basic Diam. | |
| | | | | | | | Maximum | Minimum | | |
| 1/8 | 13/32 | 0.383 | 28 | 0.0229 | 3/8 | 5/32 | 0.1824 | 0.1303 | 0.7294 | 4 1/8 |
| 1/4 | 17/32 | 0.518 | 19 | 0.0337 | 7/16 | 3/16 | 0.2188 | 0.1563 | 0.5937 | 3 1/2 |
| 3/8 | 11/16 | 0.656 | 19 | 0.0337 | 1/2 | 1/4 | 0.2917 | 0.2083 | 0.7923 | 4 3/4 |
| 1/2 | 27/32 | 0.825 | 14 | 0.0457 | 5/8 | 1/4 | 0.2917 | 0.2083 | 0.5838 | 3 1/2 |
| 5/8 | 1 1/32 | 0.902 | 14 | 0.0457 | 5/8 | 1/4 | 0.2917 | 0.2083 | 0.5838 | 3 1/2 |
| 3/4 | 1 1/16 | 1.041 | 14 | 0.0457 | 3/4 | 3/8 | 0.4375 | 0.3125 | 0.8750 | 5 1/4 |
| 7/8 | 1 7/32 | 1.189 | 14 | 0.0457 | 3/4 | 3/8 | 0.4375 | 0.3125 | 0.8750 | 5 1/4 |
| 1 | 1 11/32 | 1.309 | 11 | 0.0582 | 7/8 | 3/8 | 0.4375 | 0.3125 | 0.6875 | 4 1/4 |
| 1 1/4 | 1 11/16 | 1.650 | 11 | 0.0582 | 1 | 1/2 | 0.5833 | 0.4167 | 0.9163 | 5 1/2 |
| 1 1/2 | 1 29/32 | 1.882 | 11 | 0.0582 | 1 | 1/2 | 0.5833 | 0.4167 | 0.9163 | 5 1/2 |
| 1 3/4 | 2 5/32 | 2.116 | 11 | 0.0582 | 1 1/8 | 5/8 | 0.7292 | 0.5208 | 1.1462 | 7 |
| 2 | 2 3/8 | 2.347 | 11 | 0.0582 | 1 1/8 | 5/8 | 0.7292 | 0.5208 | 1.1462 | 7 |
| 2 1/4 | 2 5/8 | 2.587 | 11 | 0.0582 | 1 1/4 | 11/16 | 0.8021 | 0.5729 | 1.2606 | 7 1/2 |
| 2 1/2 | 3 | 2.960 | 11 | 0.0582 | 1 1/4 | 11/16 | 0.8021 | 0.5729 | 1.2606 | 7 1/2 |
| 2 3/4 | 3 1/4 | 3.210 | 11 | 0.0582 | 1 3/8 | 13/16 | 0.9479 | 0.6771 | 1.4894 | 9 |
| 3 | 3 1/2 | 3.460 | 11 | 0.0582 | 1 3/8 | 13/16 | 0.9479 | 0.6771 | 1.4894 | 9 |
| 3 1/4 | 3 3/4 | 3.700 | 11 | 0.0582 | 1 1/2 | 7/8 | 1.0208 | 0.7292 | 1.6038 | 9 1/2 |
| 3 1/2 | 4 | 3.950 | 11 | 0.0582 | 1 1/2 | 7/8 | 1.0208 | 0.7292 | 1.6038 | 9 1/2 |
| 3 3/4 | 4 1/4 | 4.200 | 11 | 0.0582 | 1 1/2 | 7/8 | 1.0208 | 0.7292 | 1.6038 | 9 1/2 |
| 4 | 4 1/2 | 4.450 | 11 | 0.0582 | 1 5/8 | 1 | 1.1667 | 0.8333 | 1.8337 | 11 |
| 4 1/2 | 5 | 4.950 | 11 | 0.0582 | 1 5/8 | 1 | 1.1667 | 0.8333 | 1.8337 | 11 |
| 5 | 5 1/2 | 5.450 | 11 | 0.0582 | 1 3/4 | 1 1/8 | 1.3125 | 0.9375 | 2.0625 | 12 1/8 |
| 5 1/2 | 6 | 5.950 | 11 | 0.0582 | 1 7/8 | 1 1/4 | 1.4583 | 1.0417 | 2.2913 | 12 1/8 |
| 6 | 6 1/2 | 6.450 | 11 | 0.0582 | 2 | 1 3/8 | 1.6042 | 1.1458 | 2.5212 | 15 1/4 |
| 7 | 7 1/2 | 7.450 | 10 | 0.0640 | 2 1/8 | 1 3/8 | 1.6042 | 1.1458 | 2.2920 | 13 3/4 |
| 8 | 8 1/2 | 8.450 | 10 | 0.0640 | 2 1/4 | 1 1/2 | 1.7500 | 1.2500 | 2.5000 | 15 |
| 9 | 9 1/2 | 9.450 | 10 | 0.0640 | 2 1/4 | 1 1/2 | 1.7500 | 1.2500 | 2.5000 | 15 |
| 10 | 10 1/2 | 10.450 | 10 | 0.0640 | 2 3/8 | 1 5/8 | 1.8958 | 1.3542 | 2.7080 | 16 1/4 |
| 11 | 11 1/2 | 11.450 | 8 | 0.0800 | 2 1/2 | 1 5/8 | 1.8958 | 1.3542 | 2.1664 | 13 |
| 12 | 12 1/2 | 12.450 | 8 | 0.0800 | 2 1/2 | 1 5/8 | 1.8958 | 1.3542 | 2.1664 | 13 |
| 13 | 13 3/4 | 13.680 | 8 | 0.0800 | 2 5/8 | 1 5/8 | 1.8958 | 1.3542 | 2.1664 | 13 |
| 14 | 14 3/4 | 14.680 | 8 | 0.0800 | 2 3/4 | 1 3/4 | 2.0417 | 1.4583 | 2.3336 | 14 |
| 15 | 15 3/4 | 15.680 | 8 | 0.0800 | 2 3/4 | 1 3/4 | 2.0417 | 1.4583 | 2.3336 | 14 |
| 16 | 16 3/4 | 16.680 | 8 | 0.0800 | 2 7/8 | 1 7/8 | 2.1875 | 1.5625 | 2.5000 | 15 |
| 17 | 17 3/4 | 17.680 | 8 | 0.0800 | 3 | 2 | 2.3333 | 1.6667 | 2.6664 | 16 |
| 18 | 18 3/4 | 18.680 | 8 | 0.0800 | 3 | 2 | 2.3333 | 1.6667 | 2.6664 | 16 |

*Machinery*

## GRINDING IN THE MANUFACTURE OF LEAF SPRINGS

Artificial grinding wheels are rapidly displacing natural sandstones in the manufacture of leaf springs. There are three principal grinding operations on springs of this type: (1) Removing the scale from individual leaves; (2) chamfering the edges of the leaves; and (3) squaring the sides of the eyes. Practice varies in different plants, and sometimes these principal operations are supplemented by others. Such exceptions, as well as the regular grinding methods employed, will be described in the following:

This type of grinding is done offhand, using a floor stand equipped with a vitrified aluminous abrasive wheel 24 inches in diameter. Each spring leaf is ground individually by being pressed against the top of the grinding wheel, which revolves in a direction away from the operator. Owing to the fact that the grinding is done on the tops of the wheels, it is impossible to use protection hoods, and therefore wheels having tapered sides are always furnished for this class of work.

Some of the stock used in leaf springs comes with a rounded edge. In such cases very little chamfering of the leaves is necessary, for this operation consists essentially of rounding and cleaning the edges. The work is done offhand on a floor stand, in the same manner as the previous operation and with the same kind of wheels. The operation of chamfering also includes the proper shaping of the ends of the leaves. Sometimes special fixtures for supporting the work are used, into which the spring leaves are inserted, and the support is used to guide the work during the grinding operation.

A Besly or Gardner double-head grinding machine is generally employed for squaring the sides of the eyes. The springs are usually assembled and the eye on each end is ground between the two cylinder wheels. One wheel is mounted on a slide and can be moved toward or away from the other by means of a foot-lever. The movable wheel is traversed toward the stationary head, until both wheels come in contact with the work which is held between them. The same amount of stock is removed from each side of the eye, which is ground to snap gage limits.

The methods of manufacture of leaf springs vary in different shops. The springs for some of the higher grade automobiles are often made as follows:

As the spring leaves come from the forge shop they are temporarily assembled, and all the edges of the leaves of each assembled spring are then ground at one time on the rim of a cylinder wheel mounted in a chuck on a floor stand. In this way a uniform size of leaves is obtained. The springs are then taken apart and the edges of the individual leaves rounded or chamfered. Formerly the chamfering, as well as squaring the sides of the eyes, was done offhand on natural sandstones. Instead of removing the scale and smoothing the leaves on a grinding wheel, polishing wheels set up with No. 46 TJ alundum grain are sometimes used.

### Comparative Costs of Artificial and Natural Wheels

As sandstones are used in some cases for grinding leaf springs, it is interesting to compare their cost with that of artificial wheels. From information recently obtained, a natural sandstone wheel 66 to 70 inches in diameter and 7 inches thick lasts from three to six weeks on this type of work. An artificial alundum vitrified wheel has an average life of about eight weeks, all other conditions being the same, and in that time an average of from 120 to 150 tons of springs can be ground. A sandstone wheel of the size mentioned costs slightly over $40, while a vitrified alundum artificial wheel 24 inches in diameter, 3½ inches thick, and with a hole 2½ inches in diameter costs $35. Considering the increased production, longer life, and price of the alundum wheel, the artificial wheel is the more economical.

* * *

## ANNUAL MEETING OF MECHANICAL ENGINEERS

The American Society of Mechanical Engineers will hold its annual meeting at the Engineering Societies' Building, 29 W. 39th St., New York City, December 4 to 7. Tuesday, December 5, will be devoted to sessions on management, materials handling, machine shop practice, power test codes, training in the industries, steam table research, and general research. On Wednesday, December 6, there will be a joint session with the Stoker Manufacturers' Association on stokers, and also a session on locomotive design. Thursday, December 7, will be devoted to sessions on power, standardization, aeronautics, ordnance, forest products, and safety codes. Among the papers on machine shop practice that will prove of especial interest are: "Gearing for Planers" by Forrest E. Cardullo; "Testing Involute Spur Gears," by M. Estabrook; "Application of Oilgear Variable-speed Hydraulic Drive to Machine Tools and Manufacturing Processes," by Walter Ferris; "Spherical Gears," by C. H. Logue; and "Power Required for Removing Metal," by F. A. Parsons. In connection with the meeting of the society, there will be an exhibition of power plant equipment at the Grand Central Palace.

TABLE 2. DIMENSIONS OF BRITISH WHITWORTH TAPER PIPE THREAD GAGES

| Nominal Pipe Size | Basic Outside Diameter of Gage | British Practice—Distance of Basic Outside Gage Diameter from Small End of Plug | American Practice—Distance of Basic Notch from Small End of Plug | Plug Height | | Ring Width | | Outside Diameter at Small End of Plug | | Root Diameter of Ring at Large End, American and British Practice |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | British Practice | American Practice | British Practice | American Practice | British Practice | American Practice | |
| ⅛ | 0.383 | 0.3114 | 0.1563 | 0.3375 | 0.3114 | 0.3375 | 0.3114 | 0.3635 | 0.3732 | 0.3469 |
| ¼ | 0.518 | 0.3625 | 0.1875 | 0.3938 | 0.3625 | 0.3938 | 0.3625 | 0.4953 | 0.5063 | 0.4616 |
| ⅜ | 0.656 | 0.4083 | 0.2500 | 0.4500 | 0.4083 | 0.4500 | 0.4083 | 0.6305 | 0.6404 | 0.5985 |
| ½ | 0.825 | 0.5208 | 0.2500 | 0.5625 | 0.5208 | 0.5625 | 0.5208 | 0.7925 | 0.8094 | 0.7505 |
| ⅝ | 0.902 | 0.5208 | 0.2500 | 0.5625 | 0.5208 | 0.5625 | 0.5208 | 0.8695 | 0.8864 | 0.8275 |
| ¾ | 1.041 | 0.6125 | 0.3750 | 0.6750 | 0.6125 | 0.6750 | 0.6125 | 1.0027 | 1.0176 | 0.9644 |
| ⅞ | 1.189 | 0.6125 | 0.3750 | 0.6750 | 0.6125 | 0.6750 | 0.6125 | 1.1507 | 1.1656 | 1.1124 |
| 1 | 1.309 | 0.7250 | 0.3750 | 0.7875 | 0.7250 | 0.7875 | 0.7250 | 1.2637 | 1.2856 | 1.2145 |
| 1¼ | 1.650 | 0.8167 | 0.5000 | 0.9000 | 0.8167 | 0.9000 | 0.8167 | 1.5989 | 1.6188 | 1.5534 |
| 1½ | 1.882 | 0.8167 | 0.5000 | 0.9000 | 0.8167 | 0.9000 | 0.8167 | 1.8310 | 1.8508 | 1.7854 |
| 1¾ | 2.116 | 0.9084 | 0.6250 | 1.0125 | 0.9084 | 1.0125 | 0.9084 | 2.0592 | 2.0769 | 2.0173 |
| 2 | 2.347 | 0.9084 | 0.6250 | 1.0125 | 0.9084 | 1.0125 | 0.9084 | 2.2902 | 2.3079 | 2.2483 |
| 2¼ | 2.587 | 0.9915 | 0.6875 | 1.1250 | 0.9915 | 1.1250 | 0.9915 | 2.5250 | 2.5440 | 2.4895 |
| 2½ | 2.960 | 0.9915 | 0.6875 | 1.1250 | 0.9915 | 1.1250 | 0.9915 | 2.8980 | 2.9170 | 2.8625 |
| 2¾ | 3.210 | 1.1021 | 0.8125 | 1.2375 | 1.1021 | 1.2375 | 1.1021 | 3.1411 | 3.1592 | 3.1037 |
| 3 | 3.460 | 1.1021 | 0.8125 | 1.2375 | 1.1021 | 1.2375 | 1.1021 | 3.3911 | 3.4092 | 3.3617 |
| 3¼ | 3.700 | 1.2042 | 0.8750 | 1.3500 | 1.2042 | 1.3500 | 1.2042 | 3.6247 | 3.6453 | 3.6031 |
| 3½ | 3.950 | 1.2042 | 0.8750 | 1.3500 | 1.2042 | 1.3500 | 1.2042 | 3.8747 | 3.8953 | 3.8541 |
| 3¾ | 4.200 | 1.2042 | 0.8750 | 1.3500 | 1.2042 | 1.3500 | 1.2042 | 4.1247 | 4.1453 | 4.1041 |
| 4 | 4.450 | 1.2958 | 1.0000 | 1.4625 | 1.2958 | 1.4625 | 1.2958 | 4.3690 | 4.3875 | 4.3521 |
| 4½ | 4.950 | 1.2958 | 1.0000 | 1.4625 | 1.2958 | 1.4625 | 1.2958 | 4.8690 | 4.8875 | 4.8521 |
| 5 | 5.450 | 1.3875 | 1.1250 | 1.5750 | 1.3875 | 1.5750 | 1.3875 | 5.3633 | 5.3797 | 5.3500 |
| 5½ | 5.950 | 1.4792 | 1.2500 | 1.6875 | 1.4792 | 1.6875 | 1.4792 | 5.8576 | 5.8719 | 5.8479 |
| 6 | 6.450 | 1.5708 | 1.3750 | 1.8000 | 1.5708 | 1.8000 | 1.5708 | 6.3518 | 6.3641 | 6.3458 |
| 7 | 7.450 | 1.6833 | 1.3750 | 1.9125 | 1.6833 | 1.9125 | 1.6833 | 7.3448 | 7.3641 | 7.3411 |
| 8 | 8.450 | 1.7750 | 1.5000 | 2.0250 | 1.7750 | 2.0250 | 1.7750 | 8.3391 | 8.3563 | 8.3392 |
| 9 | 9.450 | 1.7750 | 1.5000 | 2.0250 | 1.7750 | 2.0250 | 1.7750 | 9.3391 | 9.3563 | 9.3392 |
| 10 | 10.450 | 1.8667 | 1.6250 | 2.1375 | 1.8667 | 2.1375 | 1.8667 | 10.2833 | 10.3484 | 10.3370 |
| 11 | 11.450 | 1.9792 | 1.6250 | 2.2500 | 1.9792 | 2.2500 | 1.9792 | 11.3263 | 11.3484 | 11.3120 |
| 12 | 12.450 | 1.9792 | 1.6250 | 2.2500 | 1.9792 | 2.2500 | 1.9792 | 12.3263 | 12.3484 | 12.3120 |
| 13 | 13.680 | 2.0917 | 1.6250 | 2.3625 | 2.0917 | 2.3625 | 2.0917 | 13.5493 | 13.5784 | 13.5490 |
| 14 | 14.680 | 2.1833 | 1.7500 | 2.4750 | 2.1833 | 2.4750 | 2.1833 | 14.5435 | 14.5706 | 14.5470 |
| 15 | 15.680 | 2.1833 | 1.7500 | 2.4750 | 2.1833 | 2.4750 | 2.1833 | 15.5435 | 15.5706 | 15.5470 |
| 16 | 16.680 | 2.2750 | 1.8750 | 2.5875 | 2.2750 | 2.5875 | 2.2750 | 16.5378 | 16.5628 | 16.5450 |
| 17 | 17.680 | 2.3667 | 2.0000 | 2.7000 | 2.3667 | 2.7000 | 2.3667 | 17.5321 | 17.5550 | 17.5428 |
| 18 | 18.680 | 2.3667 | 2.0000 | 2.7000 | 2.3667 | 2.7000 | 2.3667 | 18.5321 | 18.5550 | 18.5428 |

*Machinery*

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## THE DEMAND FOR DIE-CASTINGS

There has been a remarkable expansion in the die-casting industry during the past ten years, due partly to the increased demand for lighter construction in machinery and mechanical appliances. Die-castings can be produced today of attractive appearance, having sufficient strength for any reasonable use, and considerably cheaper when produced in quantities, particularly for intricate parts, than a forging or casting which must be machined to size. Many parts used in automobile construction and many household articles can be produced more economically by the simplified method of die-casting. Holes can be cast to size, threads can be provided, and even graduations on a flat or curved surface can be cast directly on the part. The accuracy obtainable is sufficient to meet requirements in the construction of ordinary mechanical devices, except those requiring a very high degree of precision.

The demand for die-castings is constantly increasing, and new means are being developed for casting metals that could not be successfully handled in the past. The die-casting process appears to be still in its infancy, and within a few years we doubtless shall see further important developments both in the process itself and in the physical properties of the metals that can be used for die-castings.

* * *

## SCOPE OF THE TECHNICAL JOURNAL

It happens occasionally that readers of MACHINERY, deeply interested in some absorbing issue of the day, urge us to take part in the widespread journalistic discussion of the subject they have so much at heart. It may be the tariff, woman suffrage, trade unionism, the right to strike or to lock-out, high rents, the bonus, foreign debts, the league (or association) of nations, prohibition, armaments, nationalization of mines or railways—the range is wide and comprehends about all the passing and perennial questions of national and international interest.

The reason we do not participate is simple enough—MACHINERY sticks to its field. Our function as journalists is to gather for the engineering reader and present as well as we know how, accurate up-to-date information about machine design and machine shop practice. This is stating it simply, but it is a large order and requires all the editorial space MACHINERY has at its disposal. The material gathered for publication constantly presses against the limits, and so great are the industries and developments that keeping up with them demands all the energies of a large and well-trained publishing organization, with no time for other issues however interesting, attractive or important.

The technical, and to an extent the commercial, side of the machine-building industries is our business, and we believe that the great majority of MACHINERY'S readers, even those who sometimes urge us to broaden our sphere, would not thank us for injecting our views on political, economic, scientific or ethical questions—especially when these views would differ from their own, as they surely would sometimes.

Furthermore, hundreds of able writers and scholars are constantly dealing with the big questions of the day; and their data, arguments and conclusions are available to our readers in periodicals whose name is legion. These discussions do not belong in MACHINERY any more than a description of a new lathe, planer, or milling machine belongs in the *Saturday Evening Post;* and just as market prices and reports on paints, oils, drugs, metals, and other commodities would be entirely out of place and wasted in *Harper's Magazine*, so a discussion of bolshevism would be entirely out of place in MACHINERY. Writers able to handle with power and conviction great questions like the League of Nations, or the Einstein theory, would find it wholly beyond their powers to write, for the engineering reader, an intelligible description of a new milling machine. Less than half of one per cent of all the readers of the *Saturday Evening Post* would have an intelligent understanding of the design of a gear shaper, after reading a careful description of one in MACHINERY, simply because the description is for the men who already possess mechanical knowledge.

So, just as those who write for the general reader stick to what they know and understand, we believe that is what MACHINERY'S readers want us to do. "Shoemaker, stick to your last."

* * *

## FREE ENGINEERING ADVICE

Consulting engineers do not give advice on the design of shop equipment and on economical production without receiving a reasonable compensation for their work; but when a manufacturer asks a machine tool builder or maker of tooling equipment for advice, he expects to get it free of charge. The builders of machine tools and shop equipment naturally are eager to show prospective customers how their equipment can be used to the best advantage; and frequently the enquirer takes undue advantage of this condition to obtain from several builders of equipment complete layouts and plans for the manufacture of his product. From the lay-outs thus submitted he selects what appears to be the best, but he does not always place his order with the manufacturer whose engineering advice he has obtained, in this way, free of charge. Sometimes he adapts machinery already in his shop to perform the work in the way described; sometimes he buys equipment from a competitor who may furnish the required machines cheaper, but who lacks the engineering knowledge to work out the manufacturing plan that was adopted.

It has been proposed that the builders of machine tools and tooling equipment make a small charge for such engineering service as they render, whenever equipment is not ordered from them in accordance with the lay-outs, drawings or plans they have submitted for the customer's use. If this were done, machine tool manufacturers would have fewer requests to submit drawings and tool lay-outs when the customer has only a vague intention of buying new equipment.

It is difficult to distinguish between such service as the machine tool builder necessarily must render in order to impress the prospective customer with the value of his machine or equipment, and service of a general nature that can be applied to other machines as well. The builder of shop equipment must decide for himself when he is called upon to render mere consulting engineering service; and in such cases, if machine tool builders make it a rule to state that this service will be rendered free of charge subject to the placing of an order, but that otherwise the service will be charged for, fewer buyers will abuse the privilege of obtaining free engineering advice.

# Reducing the Cost of Tooling Equipment

THE distinctive value of the service rendered by the tool and contract shop has repeatedly been pointed out in MACHINERY. The great development that has taken place in this branch of the machine industry was the subject of a full page editorial last April. It is not as well known as it should be that shops equipped for making special tools, jigs, fixtures, dies, gages, and other tooling equipment are in a peculiarly advantageous position for designing and building special tools. Because they are specialists they can do this work cheaper and better than the comparatively small tool-rooms of individual manufacturing plants. A great deal of good money is wasted every day in dozens of places by designers and toolmakers of mediocre ability and limited experience, who undertake to design and build tools for special purposes. Their tools may operate in what appears to be a satisfactory manner, without anywhere nearly realizing what should be the real objective, that is, maximum efficiency. The special tool and contract shop, employing a corps of designers and toolmakers constantly engaged on high-class tooling equipment work, is in a position to produce tools that are not only better, but that can be bought for less than the manufacturer can produce them in his own tool-room.

Before the development of the special shop it was the custom, when a set of tools was required for the manufacture of a new machine or device, for the manufacturer to hire a man who represented himself as a tool designer and to gather in with him a few toolmakers, usually the kind that floated from job to job. It needs no great experience in manufacturing to realize that under these conditions very mediocre tools were produced at excessively high cost. Methods of this kind still prevail in some shops, but they are as inadequate and out of date as the lathes of thirty years ago would be if employed in high production with high-speed steel or stellite tools.

Progressive manufacturers are beginning to realize that the service offered by the tool and contract shop is an economical service. The big automobile companies were among the first of the metal-working manufacturing plants to recognize this fully, and today many of the tool equipment shops are kept busy almost entirely by the automobile industry. Methods that have proved so advantageous and economical in the automobile field would surely prove efficient and economical in other lines of manufacture. Shops making sewing machines, typewriters, hardware, engines, pumps, electric motors, washing machines, or jewelry, can be served as well by the tool and contract shop as the automobile shop has been. In few fields are the requirements for accuracy and economy greater than in the automobile field; and if the tool shop has been able to meet satisfactorily the exacting requirements of this industry, it can meet the requirements in other fields.

The manufacturer who continues to maintain an expensive tool-room of his own, except for emergency purposes, should investigate actual costs and results obtained from his tool-room, as compared with what is offered by the shop that specializes in a product and service that with him is merely a side line. Manufacturers of the hundred and one different products of modern industry know that they cannot afford to build their own machine tools. They have found that it pays to do business with shops specializing in this field. It would pay them equally well to have specialists build the tooling equipment required for the operation of machine tools, and these specialists are seldom found except in shops devoted exclusively to toolmaking. The trend is toward recognition of the definite place and special service of the tool shops. These shops are sure to grow in size and importance until they constitute the main source of manufacturing equipment aside from standard machine tools and accessories.

# New Semi-automatic Multi-cut Lathe

By WILLIAM O. STRAUSS, Engineer, R. K. LeBlond Machine Tool Co., Cincinnati, Ohio

Several improvements that increase the productive possibilities and provide greater convenience of operation have been embodied in a new and larger sized semi-automatic multi-cut lathe recently developed by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. The new machine, which is known as the No. 12 heavy multi-cut lathe, turns work up to 12 inches in diameter and is made in various bed lengths giving maximum center distances of 18, 26, 34, or 42 inches.

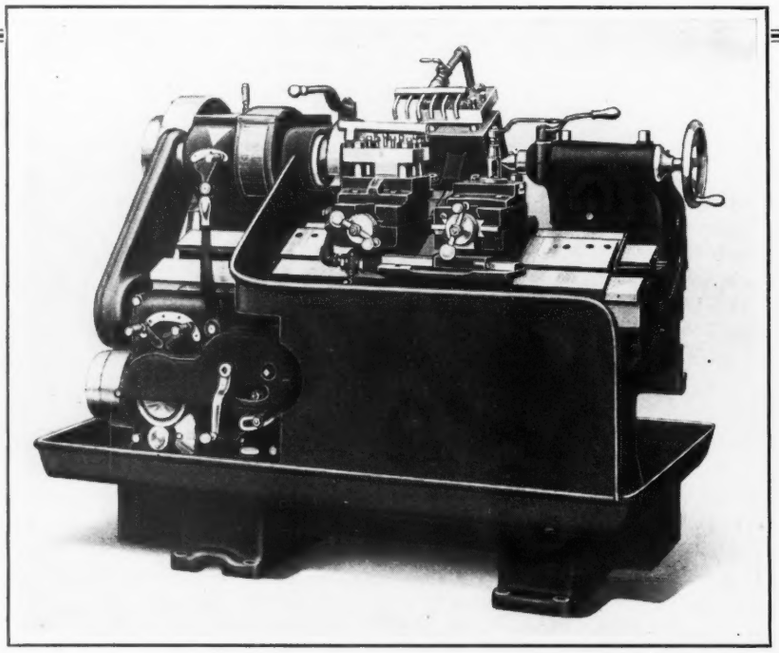

Fig. 1. Improved Heavy No. 12 Multi-cut Lathe for Work up to 12 Inches in Diameter and of Various Lengths, depending on the Length of Bed

Among the new features are: (1) A power rapid traverse for the turning carriage and facing slide; (2) an automatic arrangement which stops the spindle when the feed of the tools is stopped; (3) an automatic shutting off of the supply of lubricant to the work simultaneously with the stopping of the spindle rotation; (4) a submerged rotary pump and lubricant distributor lines of ample capacity; and (5) the derivation of all movements from simple slides on broad scraped bearings. Each of these features will be described in detail in the following.

This machine, as its name implies, may be equipped with multiple tools for simultaneously turning and facing such parts as automobile wheel hubs, transmission gears and shafts, flange and stub ends of crankshafts, motor pinions, and cone pulleys. Fig. 4 shows the "multi-cut" lathe set up for turning an alloy steel pinion, a job in which four facing and two turning tools are employed to remove about ½ inch of metal from all surfaces, the piece being completely machined to size in one operation. The floor-to-floor time per piece for this job is 4 minutes 45 seconds, and about 10 horsepower is consumed. Many plain turning and facing jobs done in the ordinary machine shop can also be handled profitably on this machine.

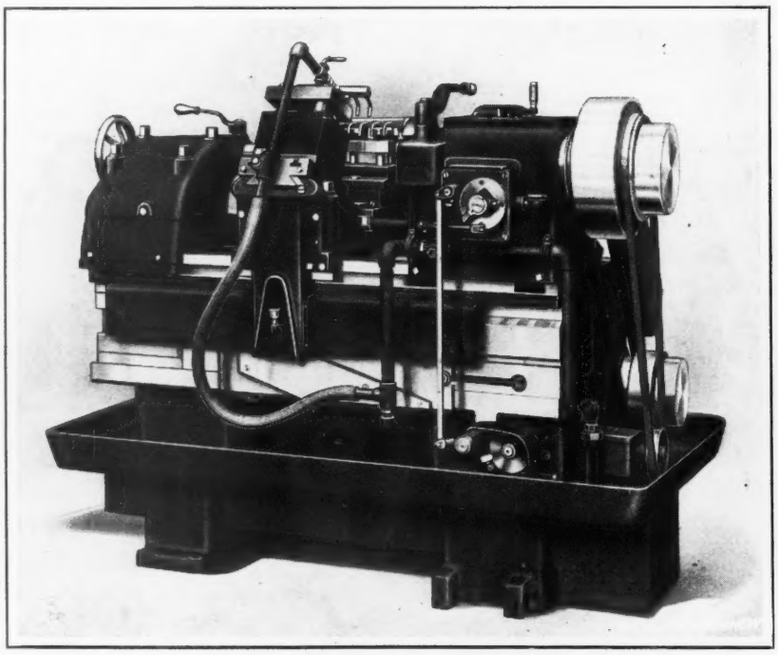

Fig. 2. Rear View, showing the Arrangement of the Facing Slide and the Profile Plate from which it receives Movement

The simplicity of the design enables the operator to set up the machine in approximately the same time as is required for setting up a hand screw machine, and because of this, the multi-cut lathe is applicable to lots of only twenty-five or fifty parts. As the machine is essentially a lathe and uses only lathe tools, the average lathe operator can be quickly trained to obtain maximum production with it. All slides are actuated without the use of cams, and so setting up for a given job simply requires the selection of the proper change-gears. These may be quickly determined from a chart.

When the volume of work is sufficient to justify it, one operator can readily take care of two machines. The turning carriage at the front of the machine and the facing slide at the rear are automatically tripped by limit stops at both ends of their travel. The feeding movements of the carriage and slide are so arranged that the time required for a job is that necessary for taking the longest single cut. Both the feeding and rapid traverse movements of the carriage and slide are controlled by means of the upright handlever of the feed-box at the head end of the machine (see Fig. 1). This control is so interlocked that the feed and rapid traverse cannot both be engaged at once. The machine is heavily constructed in order that it may utilize the unusual amount of power supplied it; although it is only rated to swing 12 inches in diameter, a motor of from 7½ to 15 horsepower, depending upon the nature of the work that is to be handled, is recommended for driving it.

### Selective Speed Headstock

Six speed changes for the headstock spindle are obtainable from the constant-speed driving pulley by the manipulation of two levers. The lever on top of the headstock gives the faster speeds, and that at the front of the headstock, the slower speeds. The horizontal lever projecting to the front of the machine at the right-hand end of the headstock is used for starting the spindle. The driving pulley is equipped with a multiple-disk clutch, which runs continuously in oil. All the headstock gears are made of nickel-steel and heat-treated, and have stub teeth to increase their strength. These teeth are rounded to permit the gears to be easily slid into engagement. The gears are mounted on short high-carbon steel shafts which have four keyways, the corresponding keys being broached in the gears from the solid.

The automatic stopping feature of the spindle, previously mentioned, is so designed that when the feed of the turning carriage and facing slide is tripped, the spindle is instantly stopped or makes a predetermined number of revolutions before stopping. The spindle boxes are adjustable for wear,

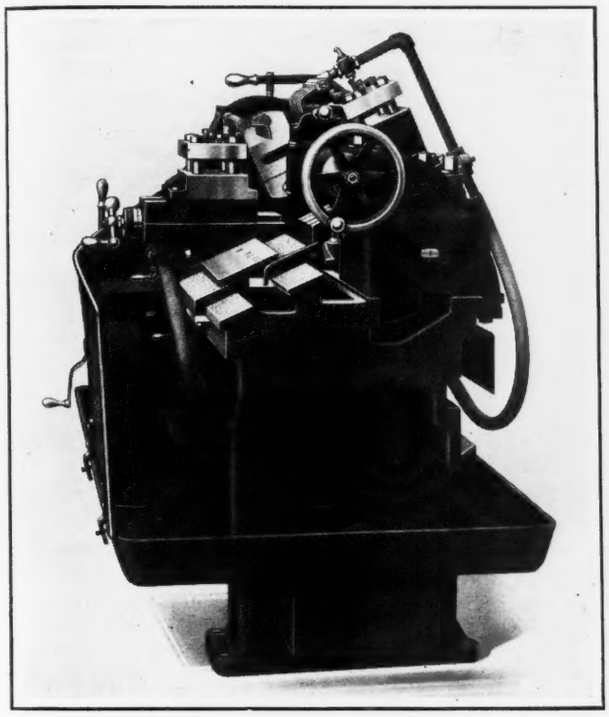

Fig. 3. Tailstock End of Multi-cut Lathe, which clearly shows the Design of the Bed Shears

and the spindle is provided with ball thrust bearings. The entire headstock mechanism is enclosed in an oil-tight casting in which every gear and bearing is constantly flooded with oil. The spindle is provided with a hole for the application of draw-in or air chucks.

### The Bed and Tailstock

One of the noticeable points in which the construction of this machine differs from the smaller sizes is in the arrangement of the shears on the bed. The front shear on which the turning carriage is mounted is at an angle, whereas the rear shear on which the facing slide operates, and on which the headstock and tailstock are mounted, is in a horizontal plane. On the smaller machines this shear is at an opposing angle to the front shear.

The turning carriage is free to travel past both the headstock and the tailstock, and because the shear is at an angle, it is claimed that the pressure of the cut serves to keep the carriage closer to the bed; thus all tendency to climb the shears and strain the gibs is eliminated. The bed is mounted on cast iron legs which are designed to receive a pressed-steel pan, tank, and settling basin for the cutting compound. Ample space between the shears of the bed allows the chips to pass through. The tailstock is of the quick-acting screw type, and has four bolts for clamping it to the bed. The spindle of the tailstock is made from 0.45 carbon steel.

### The Turning Carriage and Facing Slide

The turning carriage is scraped to the shears for its full length and is double-gibbed to the bed. The top of the carriage is provided with a broad dovetail to which the turning tool-rest is applied. One or more standard rests can be mounted on the carriage and spaced along it to suit the work. Two tool-rests are shown mounted on the carriage in Fig. 1. Any of the rests may be equipped with a taper-turning attachment so that straight and taper surfaces can be turned simultaneously. The carriage is fed along the bed by means of a steel bull gear and a rack which is placed in the center of the shears to provide a balanced drive.

The slide on which the facing tools are held is mounted on an angular bracket on the shear at the rear of the

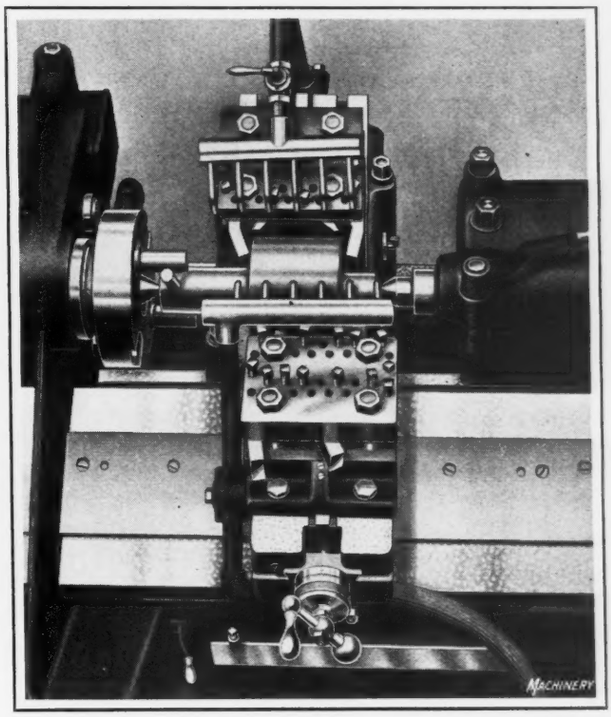


Fig. 4. Tooling of the Turning Carriage and Facing Slide for a Typical Job

machine. This slide receives its motion from the profile plate in the planed way on the rear of the bed, as shown in Fig. 2. A hardened roller attached to the facing slide is confined in the channel of the profile plate, and as the profile plate is fed along the bed, this roller, through a rack and pinion, operates the facing slide at right angles to the horizontal center line of the lathe. The contour of this profile plate is selective, so that the facing tools may be made to dwell at the end of their cut while the turning tools continue, or the profile plate may be of a shape that gradually slows up the feeding rate of the facing tools as they approach the end of their cut. This would allow for forming operations or for sizing heavy fillets.

### The Feed and Rapid Traverse Movements

Power for the feeding movements of the turning carriage and facing slide is transmitted from the headstock spindle, by means of sprockets and a chain, to the feed-box at the head of the machine. Nine basic feed changes are obtained by manipulating the two short levers on the front of this box, which operate chrome-nickel steel sliding gears. The relative feeds of the turning carriage and facing slide are

variable through change-gears which are located on the outside of the feed-box. Then, after the ratio is determined, the feeds may be increased or decreased at will by the manipulation of either feed-change lever.

The feed movement of both the carriage and slide is tripped by means of adjustable dogs on a revolving disk, which disengage a positive clutch. The disk makes one complete revolution per maximum travel of the carriage, and the latter may be tripped at any desired point by simply setting one of the tripping dogs. The operation of this dog also actuates the automatic spindle stopping arrangement incorporated in the headstock. All gears and bearings in the feed-box are constantly flooded with clean lubricant, which is supplied by a pump provided exclusively for this unit. Power for the rapid traverse movement is transmitted through a light belt from the main driving pulley to the pulley at the left-hand end of the feed-box. This pulley is connected to the rapid traverse driving shaft by means of a multiple disk clutch which runs in oil.

### Lubricating Provisions and Motor Drive

As all important units are oiled by flooded lubrication, hand-oiling is so reduced as to be an almost negligible factor. Indicators on the headstock and feed-box show the levels to which these units should be kept filled with oil. The submerged centrifugal pump is of ample capacity and does not require priming. It delivers about 15 gallons of fluid per minute under sufficient pressure to wash away all chips and cool the tools properly.

Either an alternating- or a direct-current motor can be furnished for driving the machine. The motor is mounted on a hinged plate, which is attached to the rear of the headstock cabinet leg and drives the machine through a belt connecting it to the headstock pulley. A tightener pulley mounted on roller bearings is also furnished. A constant-speed type motor of from 7½ to 15 horsepower capacity and running at 1750 revolutions per minute is recommended.

### Taper-turning Attachment

The taper-turning attachment previously mentioned consists of a heavy bracket which is bolted to a planed pad on the front of the machine. This bracket carries a swiveling guide bar, which may be clamped in any selected position by means of T slot bolts. A sliding shoe is also attached to the cross-slide to impart an in and out movement to the cross-slide which bears a definite relation to the angular setting of the guide bar. The guide bar and the sliding shoe may be replaced by a form plate and a roller for the duplication of irregular shapes. The bed is provided with a series of holes to receive the clamping screws of the taper attachment bracket, so that the taper attachment may be moved along the bed as desired.

Some of the important specifications of this multi-cut lathe are as follows: Maximum turning capacity, 12 inches diameter; maximum facing capacity, 10½ inches diameter; maximum travel of carriage (all bed lengths), 20 inches; range of spindle speeds, from 50 to 250 revolutions per minute; range of turning carriage and facing slide feeds, from 0.002 to 0.203 inch per spindle revolution; rapid traverse of turning carriage and facing slide, 128 inches per minute; maximum travel of facing slide, 5¼ inches; and maximum travel of turning tool-rest, 5½ inches.

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The annual meeting of the Taylor Society was held in the Engineering Societies' Building, November 22 to 24. A number of papers covering broadly important phases in management were read, the subjects dealt with including the organization and management of a medium-sized plant; statistical compilation; shaping management to meet developing industrial conditions; master budgets of sales and production; reduction of waste through research studies; and supervision of personnel.

## GERMAN INDUSTRIAL CONDITIONS

From MACHINERY'S Special Correspondent

Berlin, November 7

The tremendous drop in the exchange value of the mark during October has necessitated larger working capital for industrial plants, increased the scarcity of money, and made it more difficult to obtain credit for filling orders on hand. The present conditions have also caused uneasiness among the workers, and it is necessary to revise wages as well as prices of goods at very short intervals. There are many indications of a cessation of the industrial boom and of a coming crisis. This is evidenced by the fact that new orders in general are placed at much lower actual prices than in the past, and it is easier to obtain raw materials; in addition, the scarcity of labor is diminishing, and in some localities there is even a slight surplus of labor. Also the drop in the value of the mark did not increase German exports to such an extent as formerly.

### Difficulties in Obtaining Credit

The need of large working capital seems to be the dominating factor of the situation, and it is the opinion in all industrial centers that the present boom must collapse, due to a lack of working capital and credit. The scarcity of money became so serious during the past month, that many plants could not pay their employes. Some firms issued bank notes of their own for their payroll, by permission of the Reichsbank. The Krupp Aktien-Gesellschaft issued bank notes of 200- and 1000-mark denominations, and the Thyssen Aktien-Gesellschaft of Mülheim issued notes of the same denominations, and 100- and 500-mark notes in addition. These bank notes, even at this early date, are no longer valid. Practically every firm has tried to solve the problem in some way, but without success. One expedient, the issue of new shares, has failed because the bank cannot be persuaded to lend the large sums of money required.

### Changes in Prices of Machine Tools

Naturally the collapse of the mark created a complete alteration of the prices of machine tools. They are now offered at fixed prices only in instances where the machines are actually in stock. A payment on account is required when an order is placed, and it is no wonder that the amount of new orders placed is small. Employment in the machine tool industry continues to be good on account of the number of orders on hand, the filling of which will presumably take some months. Many orders were received at the Leipzig fair, and on the whole, the fair has been more successful than was expected.

Any business contract is a speculation of the worst kind, the risk of which increases according to the degree in which the manufacturer depends on foreign markets for the supply of raw materials. A new feature of the market is the basing of prices on the value of the American dollar. As a result of this practice, it frequently happens that the prices asked for almost identical machines differ greatly.

Prospects of better conditions seem poorer than ever, and the political situation appears to be hopeless. The iron industry has been a leader in setting the prices of its products according to the American dollar, and price changes in this industry now take place four times a month. Machine tool builders are careful in ordering raw materials. One large concern recently cancelled as far as possible all previous orders for raw materials. Invoicing in foreign currency, of products made from home materials as well as from foreign materials and intended for home or foreign consumption, is now being practiced for the first time by the Association of German Machine Tool Builders. This method has been adopted by the manufacturers in an attempt to keep pace with the drop in the value of the mark in relation to the dollar.

# Machine Tool Investments

By a Machine Tool Sales Manager

THE usual method of determining whether a new machine tool should be purchased or not, is to investigate the effect that it will have on the cost per piece produced. In many cases, machine tool buyers expect to reduce the cost of their product sufficiently to cover the purchase price of the machine in a single year. In other words, they expect a return of 100 per cent on the investment. From the buyer's standpoint, an investment yielding 100 per cent is ideal, and if machine tools are developed fast enough to make it possible continuously to offer investments of this type, it would be very valuable in the reduction of costs in the industries. But while such returns can be recorded for several machine tools now on the market, it is doubtful if a rate of development can be maintained that will make it possible always to offer 100 per cent investments to machine tool buyers. Of course, an automatic screw machine of today can easily show a 100 per cent return on the investment, when its production is compared with the engine lathe of twenty years ago. But it is not likely that the automatic screw machine of tomorrow will be sufficiently superior to that of today to make it possible to offer it as another 100 per cent investment. In other words, machine tool buyers must begin to consider machine tools as a good investment even if they do not give such excessively high returns.

### Reducing the Payroll by Improved Equipment

There are some advantages to be gained from the purchase of machine tools besides the actual reduction in the cost of manufacture per piece. When a machine is purchased and put to work, it is expected to earn a profit on the investment and to cover its own overhead. It is exactly the same when a machinist is added to the payroll. He is expected to earn a profit on the wages paid to him, and to cover the cost of the overhead expense added by his employment Now, suppose that a certain amount of work is to be done, and that it may be done either by using the present machinery with additional employes, or by using the same number of employes and installing new machinery. Further, assume that the actual cost per piece will be the same in either case. Which is then the better solution of the production problem?

In one case, the shop would pay out more money in wages, but the assets of the company would remain the same. If new equipment were purchased, money would also be paid out, but the company would have added to its assets. The assets would be increased to the extent of the purchase price of the machinery, less depreciation.

If anyone is in doubt as to which is the better procedure, ask a banker. It is much easier for a concern to do business with a bank when it can show that it has growing assets than when it can merely point to a growing payroll —assuming that the profit is the same in both cases. Suppose, for example, that a shop with 200 employes does $800,000 worth of business. This is $4000 per employe, which includes all expenses, wages cost of materials, insurance, rent, selling expense, taxes, and the hundred and one other items that make up manufacturing costs. Assume that by investing a large amount in modern machinery, the same output is obtained with 150 employes. Assume, further, that $2000 per year is the average cost of wages and supervision per man; then $100,000 a year has been saved in wages. If the interest and the depreciation on the machinery bought amounts to $100,000, the actual profit remains the same; nevertheless, the company is in a better financial position. The new machinery has not increased the profits, but it has increased the assets of the company. Instead of paying out wages that constitute no asset, it has turned the saving into an asset. In times of stress, the borrowing capacity of this company is greater, and it can weather business depressions and financial storms more easily.

### Reasonable Returns on Machine Tool Investments

The remarkable improvements in machine tools during recent years have led buyers of machine tools to expect unreasonably high returns on machine tool purchases. Compare the investment in machine tools with the investments made in starting a public service corporation. In the case of public utilities—railroads, electric light and power stations, gas works, and water works—large investments are made before any revenue whatever is derived, and if the return is sufficient to cover depreciation and operating expenses, and yield a profit anywhere from 6 to 10 per cent on the capital invested, the corporation is rated as a sound business.

Now the purchase of a machine tool is a sound investment on exactly the same basis. It is unreasonable to expect a 100 per cent return on the purchase price of a machine tool when a public utility that yields 10 per cent is exceptional. If a machine tool can show an actual annual saving of 20 per cent of its purchase price—10 per cent being allowed for depreciation and 10 per cent as interest on the investment—it should be considered a very good proposition. If the machine is used in an industry that has extremes of prosperous and lean years, an average of a number of years could be used, and if the average equals the figures mentioned, the investment is a sound one. A depreciation of 10 per cent wipes out the cost of the investment in ten years. Many machine tools have a longer life than that, and in any case, at the end of ten years there is a certain scrap value in the machine, and nearly always a second-hand value.,

As a matter of fact, there is probably no other industrial product that gives as high a return on the investment as machine tools. The mere fact that there are buyers in the machine tool field who today expect 100 per cent returns on their investment indicates that machine tool builders are selling their inventive ability and skill very cheaply. It also indicates that those who use machine tools get proportionately a much higher price for their product than the machine tool builder; otherwise, they could not expect a 100 per cent return on their investment. When competition becomes as keen in some of the fields where machine tools are used as it is now between machine tool builders, some buyers of machine tools will be satisfied with as low as 10 per cent return on their investments.

### What the Machine Tool Salesman can do to Correct Erroneous Impressions

One factor that has contributed to the demands for a high rate of return on machine tool investments has been that the salesman of machine tools has lacked the financial aspect. He may have been an excellent salesman and a good mechanic and demonstrator of his machine, but he has not made the financial side of the transaction one of the main items of his proposition. There is great room for improvement in the line of attack of the machine tool salesmen.

The machine tool buyer must be educated to look on a machine tool investment much in the same light as investments in other industrial fields. In order to teach him to do this, the machine tool salesman must learn to figure the return from new equipment by an accurate accounting method. If he can offer a net return of 10 per cent or more, he has an investment proposition worthy of consideration and one that will receive attention in a period when the buyers of machine tools are engaged in an active competitive business.

Machine tool salesmen devote a great deal of time in devising methods for going around, over or under, the purchasing agent. To some extent this is necessary, because the salesman must become familiar with the shop conditions, and the purchasing agent, as a rule, can give him only second-hand information on shop subjects. At the same time it should be remembered that the qualifications of purchasing agents as a whole have been raised very much faster than the qualifications of men in many other lines of endeavor. The purchasing agents today are selected because of their ability to earn money for their companies by making investments that will return profits. It will help the cause of the machine tool salesman if he is able to explain clearly to the purchasing agent that the buying of his machine tool is a real investment. The purchasing agent is looking for good investments; it is the salesman's business to show him where he can invest his company's money to good advantage.

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## RE-TURNING CRANKPINS IN AN AUTOMOBILE SERVICE STATION

In repairing automobile crankshafts it is quite common practice to regrind the crankpins and main bearings, but the repair shops of all service stations do not have sufficient use for a crankshaft grinding machine or a specially arranged cylindrical grinder to employ this method of refinishing worn crankshaft bearings. At the service station of the White Co., Long Island City, crankpins are re-turned on a Greaves-Klusman lathe in which a Sawyer-Weber returning tool is used, as illustrated. The crankshaft is chucked at one end or driven by a lathe dog and supported at the tailstock end in the regular way. The diameter of the pin to be turned is first determined, and then the 90-degree V-block *A* is adjusted to suit this diameter. For convenience in making this adjustment, a scale is provided on the opposite side. It is necessary that this V-block be adjusted for varying diameters of crankpins so that the turning tool will be located diametrically opposite the center of the pin.

The blade that does the turning is the full width of the wrist-pin and is fastened in the slide block *B*, which has suitable adjustment for diameter. A bronze shoe is brought to bear against the crankpin, the correct bearing pressure being produced by the knurled screw *C*. Then the crankshaft is revolved slowly to the front, the best results in turning being obtained if the speed of rotation is not over ten revolutions per minute. The extending bar of the tool bears against the carriage of the lathe as the shaft revolves, and the operator, standing at the rear of the machine, can then conveniently feed the tool by means of the handwheel, as shown in the illustration.

To obtain the best results with this tool, certain points must be observed, as outlined in the following: It is necessary that the cutters have a keen edge and that they be kept sharp. Low rotative speeds are productive of the best results, and the feed should not be more than 0.0005 inch per revolution of the crankshaft. Cutting compound, consisting of 50 per cent lard oil and 50 per cent turpentine should be used in copious quantities. As the cutter is gradually fed in, it is necessary to maintain a proper amount of tension of the bronze shoe against the reduced diameter of the crankpin;

Use of Crankpin Turning Tool for repairing Automobile Crankshafts

hence as the work is being performed the knurled screw *C* is tightened slightly from time to time.

This tool has been found entirely suitable for re-turning crankpins that are scored or worn out of round. In the case of a pin that is worn tapered, the revolving crankshaft will cause the end of the bar to sway considerably, and if this is not prevented by bringing the carriage against the side of the bar, the crankpin will be turned tapered. Reference has been made to the necessity of maintaining a keen cutting edge on the turning tool; to aid in maintaining this edge, it is good practice to clean the crankpins before turning with a piece of aloxite cloth to remove rust or glaze, which is destructive to the cutting edge of the tool. At the completion of the returning operation the turned surfaces may be smoothed by means of aloxite cloth held in a wood clamp or in any other suitable way, and this completes the finishing of the pins.

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## DEMAND FOR MACHINE TOOLS IN JAPAN

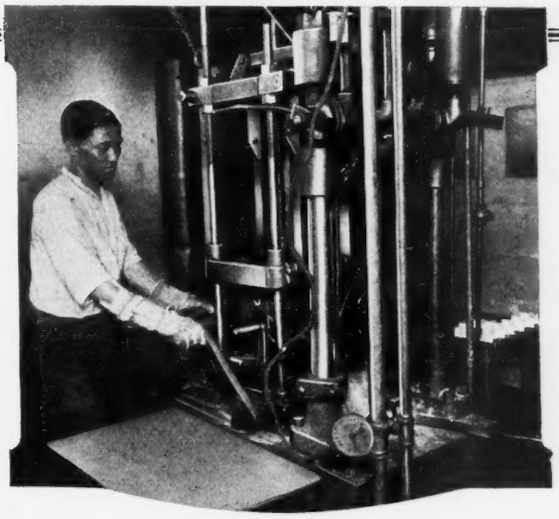
The types of machine tools chiefly in demand in Japan are given in the following information received from Mitsui Bussan Kaisha, Ltd., Tokyo, Japan, dealers in machine tools and general machinery. The kinds, types, and sizes of machine tools most in demand are as follows: Lathes, 12- to 24-inch swing; upright drilling machines, from 24 to 36-inch sizes; horizontal boring machines, from 3- to 6-inch sizes; milling machines, Nos. 2 and 3; gear-cutting machines, from 24- to 48-inch sizes; plain and universal grinding machines; and roll grinders.

In viewing the entire machinery field, it is found that the demand for machinery for different industrial uses comes somewhat in the following order: Electrical machinery, excavators, rolling mill machinery, printing machinery, and machine tools. In the machine tool class, the order of demand is about as follows: Milling machines, lathes, grinders, drilling machines, and gear-cutting machines.

Paper mill, sugar mill, and flour mill machinery are also in demand, as well as ice-making machinery. Generally speaking, machinery from the United States is preferred, English machinery comes next, and German and French machinery follow.

# Developments in Die-casting Practice

By CHARLES PACK, Vice-president and Chief Metallurgist, Doehler Die-Casting Co., Brooklyn, N. Y.



PERHAPS the greatest advance in the die-casting industry within the last eight or ten years has been the development of the aluminum die-casting process. The use of a lighter die-casting alloy than the original white metals consisting of zinc-, lead-, and tin-base alloys, has made it possible to extend the field of application to a greater degree than formerly. Many articles in common use are now being regularly made by die-casting. In the manufacture of automobile steering apparatus, magneto and ignition systems, carburetors and pumps, player pianos and phonographs, calculating machines, vacuum sweepers, etc., aluminum and zinc die-castings are extensively used.

Examples of some of these aluminum products are shown in Figs. 1 and 2. Fig. 1 is a complete set of die-cast parts for a well-known make of vacuum sweeper. The parts shown are of widely differing designs and involve many special applications of die-casting. Fig. 2 shows adding machine and calculating machine castings and gives a good idea of what can be done with this process in producing castings of large size and thin wall sections.

With the greater field of application afforded by the use of aluminum alloys, there necessarily has been an attendant development in the manufacture of suitable die steels because the casting temperature of aluminum is much higher than that of other white metals. There has also been a development in the types of die-casting machines used to meet the more varied application, although there still remains considerable opportunity for development in machines. Die-casting alloys have been fairly well standardized among the manufacturers of die-castings, and a great deal has already been published regarding the composition of these alloys.

### Die-casting Dies

Die-castings may be defined as castings made in metallic dies, or molds, under pressure. Die-casting dies consist of two main metallic members analogous to the cope and drag of a sand mold. For zinc-, tin-, and lead-base alloys, these die members are usually made of low-carbon machine steel, while for aluminum castings, heat-treated chrome-vanadium steel is generally used. Each half of the die can be made of a great many component parts, but when assembled the dies must open and close in two sections. The cavities, holes, and other irregularities on the casting are produced by steel cores, which are usually made of the same kind of steel as the dies. The cores are operated by pinions that engage rack teeth cut on the cores, or in some cases by levers. Usually the cores are located in the die that is drawn away from the melting pot.

The most descriptive names for the two die members are "ejector-die" for the movable member, and "cover-die" for the stationary one through which the metal is admitted to the die cavity. As a general rule, it is advisable to place the cores in the ejector-die, although conditions affecting the parting sometimes make it preferable to place them in the cover-die. In back of the ejector-die there is an ejector-plate in which pins are carried for removing the casting from the die impression. These pins pass through the die-block to the cavity in the ejector-die. The sprue-cutter is a steel stud projecting from the ejector-die far enough to enter the bushing in the cover-die. The cover-die is usually of simple construction containing merely an impression and the bushing through which the metal enters the die.

It is advisable to design the dies so that the casting will remain in the ejector-die when the two are open. The ejector-plate carrying the pins can then be advanced to cause the pins to extend slightly into the die cavity and eject the casting. Sometimes the die cavity will not be irregular enough to cause the casting to remain in the ejector-die of itself, and in such cases the sprue-cutter may be employed to hold the casting in until the dies have been opened. In such a die, the sprue-cutter is made tapered, and after the casting has been made, the sprue shrinks around the sprue-cutter, causing the casting to remain in the ejector member.

The function of the sprue-cutter is to distribute the liquid metal, not to actually sever the metal. It furnishes enough displacement in the bushing leading to the nozzle to insure that the die cavity will be completely filled. It is usually necessary to remove the sprue from the casting in a separate operation. The sprue-cutter may be stationary or movable; if it is movable, it is operated by a lever or pinion. For aluminum work, it is quite likely to be made movable, although it is not generally necessary to move it when other white metals are being cast.

The ejector-pins must fit accurately in the holes in which they operate, and yet must be capable of moving freely. They leave their impression on the casting, because it is practically impossible to have the ends of the ejector-pins project to exactly the same plane as the surface of the die impression. As a consequence, marks will be left on the casting in every case, either in the form of slight projections or depressions. Where the part is such as to r[illegible] finishing, it will be readily appreciated that a depression will be objectionable, whereas if the part is to bear upon another part in service a projection on the surface of the casting would be objectionable, while a depression would not be. From this it will be appreciated that the designer should know the service to which the part is to be put.

### Location of Parting Line

The location of the parting line of the two die members is of paramount importance, and to determine where the best place for this line is, requires a knowledge of the art of casting production. There is likely to be a greater variation in the casting dimension at the parting than at any other point. This is so because it is not always certain that the two die members will be completely closed, for if they are left open only a few thousandths of an inch by some slight particle on the face of the dies, an opportunity for variations is afforded. Sometimes it is necessary to

employ a great deal of ingenuity to make it possible for the part to be removed from the die, in which case no matter where the parting line is, special means are necessary to free the casting. For this purpose section core pieces are often used, which are removed from the casting after it is ejected from the die.

Running a line of cold water through the dies prolongs their life. Dies for castings of considerable mass, that is, bulky designs, require water-cooling, although for castings of thin wall section it is not necessary to cool the dies in this way. This is true whether the metal is aluminum or one of the other white metals of lower melting temperature. If the cores are of large diameter, it is often necessary to water-cool them as well, by running a pipe or tube into the die or core, directing it to the place that is subjected to the greatest degree of heat. A suitable drain pipe should, of course, be provided for carrying off the cooling water.

In designing die-casting dies, much depends upon the design of the part to be cast. When a drawing of a part is received by the Doehler Die-Casting Co., the engineering department determines what changes in design are necessary, if any, to cast the part satisfactorily. A drawing is then made on which the recommended changes are indicated, and the casting limits specified. Other suggestions regarding allowances for finish, casting material, etc., are also noted on this drawing. An attempt is made to keep the sections of the casting as uniform as possible. Large fillets and thin sections are most desirable, and undercuts are avoided wherever possible, because they involve complicated construction.

A blueprint of this drawing is forwarded to the customer for his approval, and if the limitations set down by the engineering department meet the requirements of service satisfactorily, and the design is approved by the customer, the actual designing of the dies is undertaken. In designing the die, draft must be provided for the interior walls and holes. The outer walls can sometimes be made without draft by using slides which move away from the casting before it is ejected. The use of slides also makes it possible to cast under-cuts on the sides of the part.

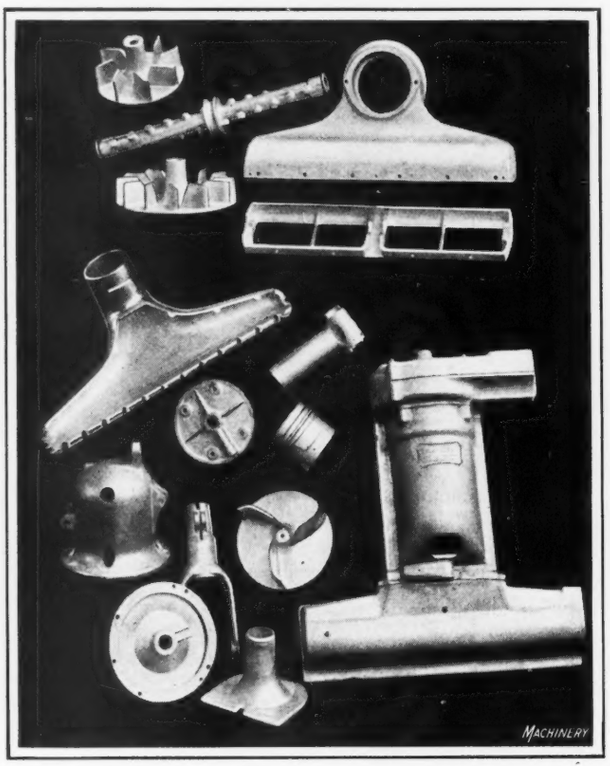



Fig. 1. Die-cast Parts for a Vacuum Sweeper

### Draft Required in Dies for Castings Made from Different Alloys

The amount of draft commonly used for each of the alloys is approximately as follows: For zinc-base alloys, 0.001 inch per inch on both the cores and walls; for tin- and lead-base alloys, 0.0005 inch per inch for the cores, and 0.001 inch per inch for the walls; for aluminum, 0.015 inch per inch for cores ¼ inch or more in diameter, and 0.005 inch per inch for cores less than ¼ inch in diameter, and for the walls 0.005 inch per inch; for copper-base alloys (brasses and bronzes), 0.005 to 0.010 inch per inch for the cores, and 0.002 inch per inch for the walls.

Accuracy and uniformity are important factors in die-casting production. Calculation for shrinkage and careful construction of the die are vital considerations in obtaining accuracy and uniformity. For casting aluminum, a shrinkage allowance of 0.004 inch per inch is made; for zinc-base alloys, the shrinkage allowance is 0.0025 inch per inch, and for tin- and lead-base alloys, 0.001 inch per inch.

It is of great importance that all these factors entering into the die design be taken into consideration because errors necessitate changes involving a heavy expense, due to the high cost of die-casting dies. It is well for the designer to bear in mind that it is comparatively easy to add stock to the outside of the casting, since that involves only enlargement of the die, but it is extremely difficult, and often impossible, to reduce the outside dimensions of the die-casting, as this means reducing the size of the impression. To guard against this, and also to facilitate the machining of the die members, the cavities themselves are often made in sections, although in any event changes should be guarded against.

As previously stated, the alloys commonly used for die-casting are fairly well standardized. The composition and properties of some of the alloys which the Doehler Die-Casting Co. has adopted as standards were presented in an article published on page 282 of November, 1920, MACHINERY.

Zinc-base alloys consisting mainly of zinc and tin or zinc and aluminum have a specific gravity of 7.20. The heaviest casting recommended to be made from these alloys is 8 pounds, the thinnest wall section, 1/16 inch, and the tolerance that can be maintained per inch, ± 0.001 inch. External threads as fine as 24 per inch can be cast, and also internal threads under certain conditions. The minimum hole diameter that can be cast with zinc alloys is 1/32 inch, although this size is influenced somewhat by the length and thickness of the casting wall.

Tin-base alloys, which include the babbitts, consist mainly of tin, lead, and antimony. The specific gravity of these alloys is 7.40, the maximum recommended weight of a die-casting made from them, 10 pounds, and the minimum wall thickness, 1/32 inch. The castings can be held to a tolerance of ± 0.0005 inch per inch. External threads as fine as 27 per inch can be cast, as well as internal threads in some cases. The minimum diameter of hole that can be cast is 1/32 inch, but this size is also influenced by the length and thickness of the casting wall.

For the lead-base alloys, which consist of lead, tin, and antimony, the specific gravity is 10.03 and the maximum weight recommended for castings made from these alloys is 12 pounds. The minimum wall thickness is 1/32 inch, and the tolerances are ±0.001 inch per inch. External threads can be cast as fine as 24 per inch, and internal threads can also be cast under some conditions. The smallest diameter of hole that can be cast is 1/32 inch, but this size is governed somewhat by the thickness of the casting wall.

Aluminum alloys consist of aluminum and copper principally, or aluminum, copper, and nickel, and their specific gravity is about 3.003. The maximum recommended weight of an aluminum casting is 5 pounds. The thinnest wall section that can be successfully cast is 1/16 inch for small castings, and ⅛ inch for large castings. Aluminum castings

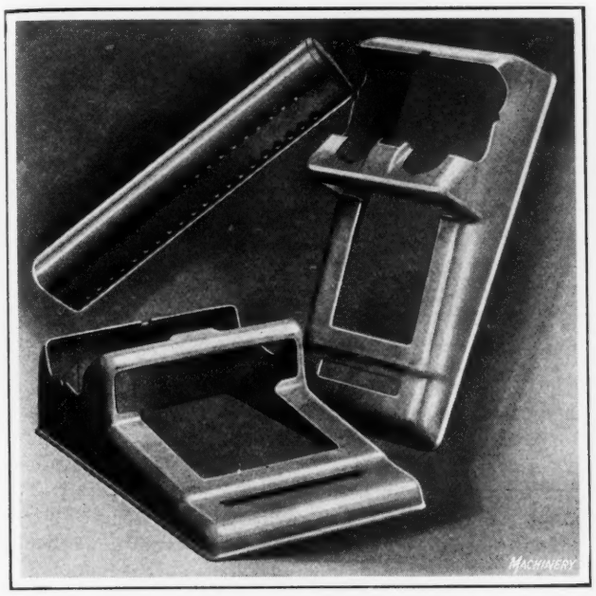


Fig. 2. Die-castings used in Adding Machines and Calculating Machines

can be held to a tolerance of ± 0.0025 inch per inch. External threads can be cast, but they must be cast 0.010 inch over size and then chased to size. The finest external thread that is recommended for aluminum castings is 20 per inch. Internal threads cannot be cast. The minimum size of holes for aluminum castings is 3/32 inch on holes not deeper than 1 inch; for holes smaller than this, it is customary to spot the casting to facilitate subsequent drilling.

For the copper-base alloys consisting of copper and zinc (manganese bronze), 14 pounds is the maximum weight recommended for die-castings. The minimum wall thickness is 3/64 inch, and the tolerances ± 0.005 inch per inch. It is not possible to die-cast threads from copper-base alloys. The smallest diameter of hole that can be cast is ½ inch, smaller holes being spotted to facilitate drilling.

The figures given in the foregoing are, of course, only approximate, since some dimensions on a given casting can always be held closer than others. For example, at the parting line there is a greater variation than elsewhere on the casting. Alloys having a lower melting point can be held within closer limits than those having a higher melting point, so that aluminum with its higher melting point cannot be held as close to a specified dimension as the other white metals.

Subsequent articles will deal with types of die-casting machines, methods of designing die-castings, and the means by which difficulties met with in the die casting process are overcome.

* * *

## EFFECT OF CERIUM AS AN ALLOY METAL

The study of cerium as an alloying element in steel, conducted at the Ithaca, N. Y., field station of the United States Bureau of Mines, has been finished. The attempt to utilize the cerium group of metals, made from by-products of the gas mantle industry, in metal alloys gave only negative results. In aluminum alloys, the cerium group of metals had no useful effect either as alloying materials or as scavengers. In steel, the desulphurization effected by the cerium metals was accompanied by the retention in the steel of inclusions due to the cerium metals. The harmful effect of the inclusions overbalanced any good effect due to desulphurization or to the presence of cerium metals as alloying elements. Neither plain carbon steel nor various alloy steels to which cerium was added were improved. Collected data showed cerium to have no marked effect as a true alloying element in steel, and to be harmful rather than helpful when used as a scavenger.

## MAKING A MOLD FOR A LARGE BRACKET

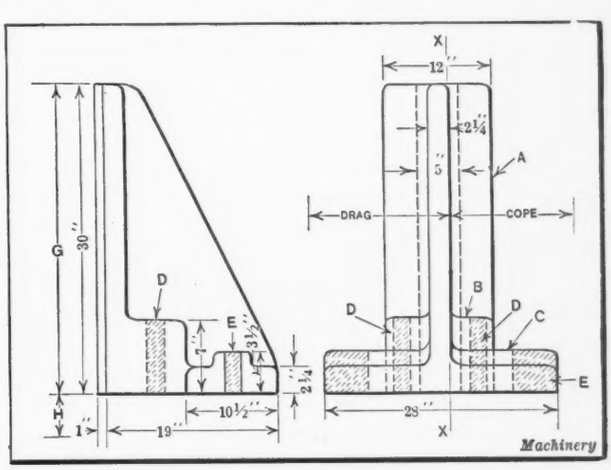
By M. E. DUGGAN

The majority of patternmakers would doubtless construct a pattern such as the one shown in the illustration with a parting line at *X*–*X*. The original pattern was made in this way, and was intended to be molded on its side, with the left-hand section of the pattern in the drag and the right-hand section in the cope, as indicated. The pieces *A*, *B*, and *C* on the cope side were loosely fastened to the pattern, while the corresponding pieces on the drag side were securely fastened in place. Core-prints and special core-boxes were made to form the bolt holes at *D*. The bolt slots *E* were cut into the pattern and were intended to be molded in green sand.

However, when the pattern reached the foundry, the loose pieces on the cope side were securely nailed to the pattern by the molder. Then, instead of making the mold in the manner intended by the patternmaker, the pattern was molded on end entirely within the drag flask. The section *G*, as indicated in the illustration, represents the drag, and the section *H* the cope. The cope was therefore flat, and of the type commonly referred to as a "flat back" cope. The slots at *E* and the holes at *D* in this case were formed by dry sand cores rammed up with the pattern. These cores, usually called "ram-up" cores, were shaped from slab cores such as are kept on hand in nearly all foundries.

When patterns, such as the one described, are returned from the foundry with the loose pieces fastened to the pattern and the cope and drag sections securely fastened together, it is evident that the molder prefers to mold the pattern on end in the drag flask. In so doing, the chance of damaging the mold when locking or closing it is greatly lessened. Then, again, instead of having to draw a fairly deep pattern from the cope as well as from the drag, only one (the drag) pattern is required to be drawn. Also, if the two-part pattern is used, wooden sand bars shaped to conform to the outline of the pattern are required to support the sand in the cope. In addition it might also be necessary to drive nails into the sand bars and provide gaggers dipped in clay and laid around the mold above the pattern to give the cope mold additional support.

From the foregoing it will be evident that the molder prefers to mold the whole pattern in the drag. This, however, is not always possible, as certain conditions make it necessary to employ a split pattern designed to be molded on its side. Needless to say, the best results in patternmaking will be obtained only when the patternmaker keeps in close touch with the foundry work. By making personal visits to the foundry and by reading articles on molding and foundry practice in technical journals, it is possible for the patternmaker to obtain a better understanding of how patterns should be constructed so as best to meet the molder's requirements.




Pattern used in producing Cast-iron Bracket

# Designing Power Press Crankshafts

By P. A. FRIEDELL, Chief Engineer, D. H. Stoll Co., Buffalo, N. Y.

VARIOUS methods of calculating the strength of crankshafts and eccentric shafts for power presses are used by different designers. These methods give different results for presses of the same tonnage capacity, and consequently a designer has difficulty in deciding which is best. In this article is described a method which has been used by the writer for a number of years and has been found to be very reliable. Crankshafts are made from steel of various compositions, but a steel having a carbon content lower than 0.25 per cent or higher than 0.50 per cent should not be used. Steels of the lower carbon content "set" too readily under load, and cause misalignment of the bearings and consequent cutting and heating. The higher carbon steels will not withstand the constant severe stresses produced by shocks, as in blanking and piercing. Open-hearth steel having a carbon content of from 0.40 to 0.50 per cent is most satisfactory for crankshafts.

### Designing the Crankshaft for a Single-crank Press

The tonnage capacity is the main consideration in designing a crankshaft. Other items that affect the dimensions are number of cranks; distance between cranks; method of driving crankshaft—at one end, at both ends, or between the cranks; length of stroke; and percentage of stroke during which the crankpin carries the full load. As a first problem a crankshaft will be calculated for a single-crank press intended for blanking and piercing operations and having a capacity of 200 tons. Allowable stresses of 10,000 pounds per square inch for shearing and bending will be used in all computations. A trial value for the crankshaft diameter $d$, Fig. 1, may be obtained by dividing the tonnage by 3, and extracting the square root of the quotient. This gives a diameter of approximately 8 inches. For the trial crankpin diameter $D$ select a value which will give an area 50 per cent greater than the area of a shaft of diameter $d$. Then the trial value of diameter $D$ will be found to be approximately 10 inches. To obtain the length $E$ of the crankpin bearing, divide the tonnage by twice diameter $D$, and add 0.2 $D$ for radii $R$. Thus,

$$E = (200 \div 20) + 2 = 12 \text{ inches}$$

This length will be satisfactory so far as the bearing area is concerned. However, when the design incorporates a connection screw for adjustment, the following formula, in which $P$ equals the total load in tons, should be used:

$$E = \sqrt{2\left(\sqrt{\frac{P}{5}} + \tfrac{1}{4}\right)^2} + \tfrac{3}{4} + 2R$$

Substituting the known values,

$$E = \sqrt{2\left(\sqrt{\frac{200}{5}} + \tfrac{1}{2}\right)^2} + \tfrac{3}{4} + 2 \times 1 = 12.04 \text{ or } 12 \text{ inches}$$

The greater of the values found for $E$ by the two formulas should be taken as the true length of the crankpin. Although both formulas give the same value in this instance, there is sometimes a considerable variance in the results. The crank cheek widths $C$ should be made approximately $0.6d$, or, in this case, 4.8 inches. Radius $F$ should equal $0.1d$ or about ¾ inch. Adding the various values, length $B$ will be found to equal about 21½ inches, and length $L$, 23 inches.

### Calculating Bending and Twisting Moments and Shearing Force

With the liberally proportioned crankpin and crank cheeks which the trial formulas give, the crankshaft may be considered as a beam on which the load is evenly distributed over distance $B$ and which is supported at points $N$. Then the approximate bending moment $M$ may be found from the following formula, in which $W$ equals the total load on the beam in pounds:

$$M = \frac{W}{4}\left(L - \frac{B}{2}\right) \qquad (1)$$

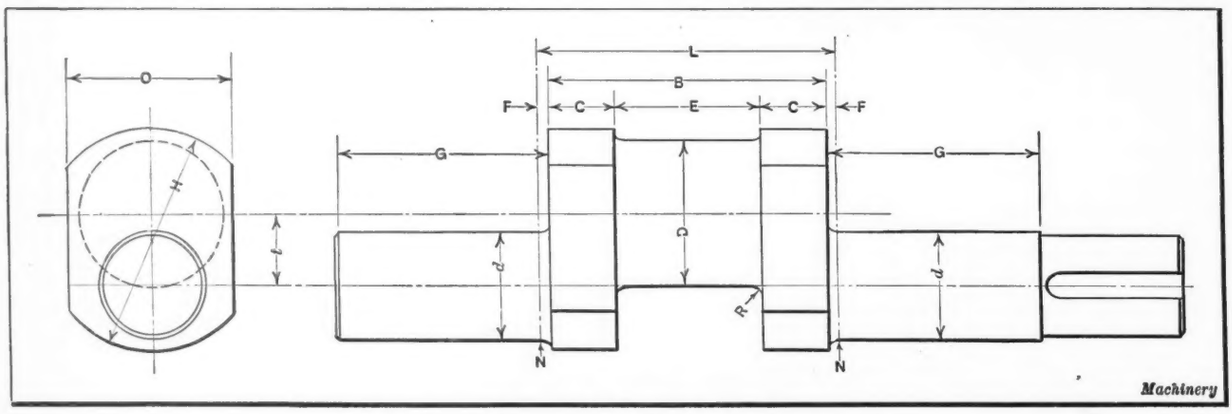



Fig. 1. Single Crankshaft for which Dimensions are computed

Substituting the known values,

$$M = \frac{400{,}000 \times 12.25}{4} = 1{,}225{,}000 \text{ inch-pounds}$$

Crankshafts are generally designed to receive the maximum load when the axis of the crankpin is not more than one inch from the vertical center line of the crankshaft bearings. Consequently, the twisting moment equals the press capacity, in pounds, multiplied by one inch, or in this case 400,000 inch-pounds.

The stroke should be as short as is practicable, considering the work to be done, because if the crankshaft is designed to receive the maximum load with the crankpin one inch from the axis of the crankshaft bearings, a press with a 2-inch stroke is able to withstand its maximum load throughout the entire stroke, whereas with a press having a 4-inch stroke and a 15-inch connection, the maximum capacity is utilized only through a distance $X$, which may be determined by the following formula:

$$X = a + c - \sqrt{(\sqrt{c^2 - 1} + a)^2 - 1}$$

in which $a$ = length of connection and $c$ = throw.

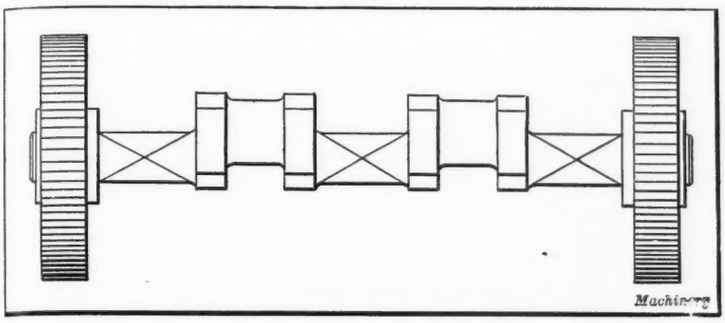


Fig. 2. Typical Double Crankshaft driven at Both Ends

Substituting the known values,

$$X = 17 - \sqrt{(\sqrt{4-1}+15)^2-1} = 0.3 \text{ inch}$$

This indicates that value $X$ drops off rapidly for increased length of stroke. It will be noted from Fig. 1 that the crankshaft is subjected to shear at points $N$, which equals 100 tons or 200,000 pounds at each point.

### Determining the True Crankshaft and Crankpin Diameters

The following formula for diameter $d$, in inches, may be used for a crankshaft made of open-hearth steel having the carbon content recommended in the foregoing:

$$d = \sqrt{\left(1.72\sqrt[3]{\frac{T}{10{,}000}}\right)^2 + \frac{Q}{10{,}000}} \qquad (2)$$

in which $T$ equals the twisting moment, in inch-pounds, and $Q$ equals the shear at either of points $N$. Substituting the known values in this formula,

$$d = \sqrt{\left(1.72\sqrt[3]{\frac{400{,}000}{10{,}000}}\right)^2 + \frac{200{,}000}{10{,}000}} = 7\tfrac{1}{2} \text{ inches}$$

As the crankpin is subjected to bending stresses, other stresses on a single crankshaft are insignificant. Therefore the crankpin diameter $D$ may be found by the following formula,

$$D = \sqrt[3]{\frac{32\,M}{\pi S}} \qquad (3)$$

in which $S$ equals the allowable stress in pounds per square inch. Taking 10,000 pounds per square inch as the allowable stress and substituting the other known values,

$$D = \sqrt[3]{\frac{32 \times 1{,}225{,}000}{3.1416 \times 10{,}000}} = 10.76 \text{ or } 10\tfrac{3}{4} \text{ inches}$$

Thus a crankshaft in which $d$ equals 7½ inches and $D$ equals 10¾ inches will safely deliver a load of 200 tons at a point 0.3 inch from the bottom of the stroke on a 4-inch stroke press, and through the entire stroke of a 2-inch stroke press. Knowing the true values of $D$ and $d$, dimensions $O$ and $H$ can be determined for a 2-inch stroke press as follows:

$$O = D + 2R = 10.75 + 2 = 12.75 \text{ inches}$$

$$H = \frac{D + d + 2t}{2} + 2R = \frac{10.75 + 7.5 + 2}{2} + 2 =$$

12.125 inches

Lengths $G$ of the main bearings should be not less than 1.75 times the true diameter $d$. In this case, $G = 1.75 \times 7.5 = 13.125$ inches. It is often necessary to make these lengths greater than 1.75 $d$ due to the design of other parts. The bearing pressure $V$, in pounds per square inch, may be computed from the formula:

$$V = \frac{W}{2\,Gd}$$

or, for a bearing equal to 1.75 $d$,

$$V = \frac{W}{3.5d^2}$$

For the crankshaft under consideration,

$$V = \frac{400{,}000}{3.5 \times 7.5 \times 7.5} = 2030 \text{ pounds per sq. in.}$$

This value for main bearings, should not greatly exceed 2000 pounds.

If it were desired to design a crankshaft for a 10-inch stroke, say for drawing a shell 5 inches deep, the capacity at a point 5 inches from the bottom of the stroke would equal

$$\frac{1960d^3}{5} = \frac{1960 \times 7.5^3}{5} = 165{,}400 \text{ pounds or } 82 \text{ tons}$$

The capacity would increase in value until the bottom of the stroke was reached, at which point the maximum load of 200 tons could be applied.

Should a crankshaft of 10-inch stroke be desired to transmit a load of 200 tons throughout its entire stroke, it would be unnecessary to change the diameter of the crankpin. However, the diameter of the crankshaft would need to be increased to compensate for the greater twisting moment, which would equal 400,000 × 5 or 2,000,000 inch-pounds. Then the crankshaft diameter $d$ would be as follows:

$$d = \sqrt{\left(1.72\sqrt[3]{\frac{2{,}000{,}000}{10{,}000}}\right)^2 + \frac{200{,}000}{10{,}000}} = 11 \text{ inches}$$

A crankshaft in which the diameter $d$ equals 11 inches, diameter $D$, 10¾ inches, and the other dimensions are as calculated, would be capable of exerting a pressure of 200 tons throughout its entire stroke, but not more than this pressure, because, while the crankshaft is sufficiently large at its bearings to withstand the maximum twisting moment obtained with a 200-ton load at a radius of 5 inches, the crankpin would be designed only for the bending stress caused by a load of 200 tons.

### Crankshafts Having More than One Crank

Little advantage is gained by providing a crankshaft with more than two cranks unless it is desired to keep the slide or ram as light as possible, in which case the extra weight would be placed in the crown of the press. In increasing the number of cranks, the capacity of the crankshaft is increased only when each crank is driven separately. For instance, if the crankshaft previously considered were designed with two crank and driven from one end only, the capacity would still be 200 tons. However, if this double crankshaft were driven from both ends, as shown in Fig. 2, or between the cranks, as shown in Fig. 3, its tonnage capacity would be double, or 400 tons.

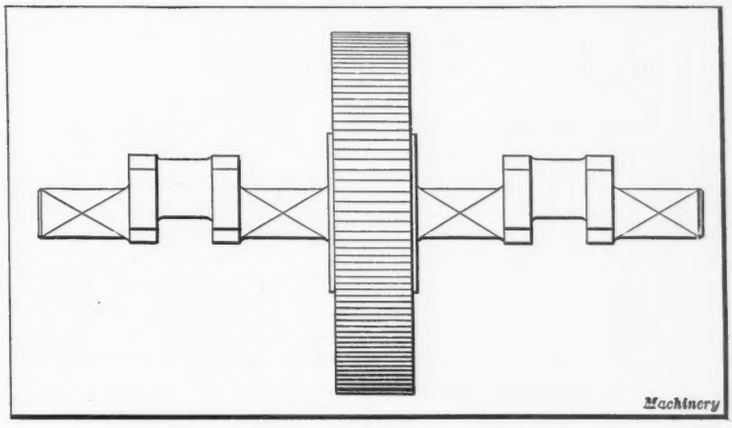


Fig. 3. Double Crankshaft driven between the Two Cranks

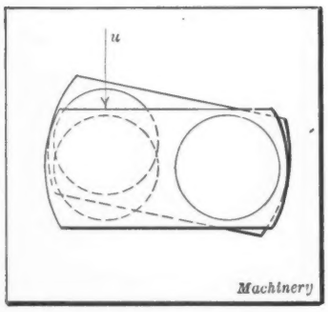



Fig. 4. Application of Force u

When a crankshaft is driven at one end only, power is transmitted through the shaft to the first crank, which performs one-half the work. This crank, in turn, transmits power to the second crank for doing the remainder of the work. The first crank receives only half the direct bending moment; however, there is still another bending moment or effort to be considered, which is similar to that of a cantilever loaded at the end. This moment $u$ also tends to twist the first crankpin, as shown on an exaggerated scale in Fig. 4, in the transmission of power to the second crank. From this it will be inferred that with a double crankshaft driven from one end, the crank at the driving end must be doubly strong to carry half the load on the ram and also to drive the second crank.

Value $u$ changes under different conditions of stroke, crankpin diameter, etc., and is only equivalent to the twisting moment of an eccentric shaft. It may be determined by means of the formula $u = \frac{WE}{4t}$. With a double crankshaft driven at one end, and having a stroke of 20 inches and the other conditions the same as in the previous problem,

$$u = \frac{400{,}000 \times 12}{4 \times 10} = 120{,}000 \text{ inch-pounds}$$

In transmitting the load through the second crank cheek of the first crank, back to the crankshaft, the twisting moment is again 200,000 inch-pounds. Then, from Formula (2) the crankshaft diameter beyond the first crankshaft should be

$$d = \sqrt{\left(1.72\sqrt[3]{\frac{200{,}000}{10{,}000}}\right)^2 + \frac{100{,}000}{10{,}000}} = 5.639 \text{ or } 5\tfrac{3}{4} \text{ inches}$$

Assuming diameter $D$ of the crankpin to be 7 inches, the various values can be found by the same method as was used for the single crankshaft. Thus,

$E = 100 \div 14 + 1.4 = 8.5$ inches
$C = 0.6 \times 5.75 = 3.45$ or $3\frac{1}{2}$ inches
$B = 8.5 + 7 = 15\frac{1}{2}$ inches
$F = 0.1 \times 5.75 = 0.575$ or $\frac{1}{2}$ inch
$L = 15.5 + 1 = 16.5$ inches

Then the bending moment $M$ may be found by substituting known values in Formula (1), $W$ in this case equaling one-half the total load, or 200,000 pounds.

$$M = \frac{200{,}000 \times 8.75}{4} = 437{,}500 \text{ inch-pounds}$$

Then, using Formula (3)

$$D = \sqrt[3]{\frac{32 \times 437{,}500}{3.1416 \times 10{,}000}} = 7.64 \text{ or } 7\tfrac{5}{8} \text{ inches}$$

While a crankshaft of the dimensions given would withstand all stresses imposed upon it, its design would be impracticable. It is thus customary to make the dimensions of the second crank identical with those of the first, and the dimensions of the second and third bearings the same as in the first.

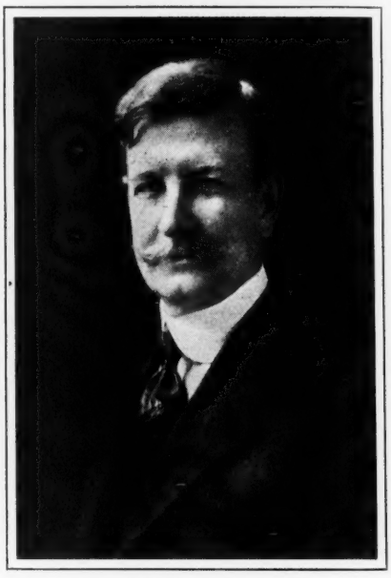
Crankshafts for operation at medium or low speeds, and transmitting heavy loads, should preferably be mounted in fine-grained cast-iron bearings scraped to a good running fit. The crankshafts should be run under moderately high loads at first. After cast-iron bearings have been properly run in, plenty of oil being used, they become most durable and satisfactory for high and medium loads transmitted at low or medium speeds, and are superior to most bronzes.

## NEW PRESIDENT OF A. S. M. E.

The new president of the American Society of Mechanical Engineers, John Lyle Harrington, was born at Lawrence, Kans., December, 1868. After a brief business experience, he entered the University of Kansas in 1891 and graduated in 1895 with the degrees of A.B., B.S., and C.E. Later he received the degree of M.S. from McGill University, Montreal.

His first six years after graduation were devoted to bridge, structural and mechanical work with J. A. L. Waddell, consulting engineer, Kansas City, Mo.; with the Elmira Bridge Co., Elmira, N. Y.; with the Pencoyd Iron Works, Philadelphia, Pa.; with the Keystone Bridge Works of the Carnegie Steel Co., Pittsburg, Pa.; with the Cambria Steel Co., Johnstown, Pa., for whom he designed and supervised the construction and equipment of the bridge and structural shops; with the Bucyrus Co., South Milwaukee, Wis., as assistant chief engineer; with the Northwestern Elevated Railway Co. of Chicago, as assistant chief engineer in charge of the detailing and fabrication of the metal work in the shops; with the Berlin Iron Bridge Co., East Berlin, Conn., as designer; and with the Baltimore & Ohio Railroad Co. as assistant engineer of bridges and buildings.

From 1901 to 1905 he served as executive engineer and manager of the C. W. Hunt Co., New York City, and during 1905 and 1906 as chief engineer and manager of the Locomotive Machine Co. of Montreal, a subsidiary of the American Locomotive Co. From 1907 to 1914 he was a member of the firm of Waddell & Harrington, consulting engineers, Kansas City, and from 1914 up to the present he has been the senior partner of the firm of Harrington, Howard & Ash, consulting engineers, Kansas City. During his work as a consulting engineer, which has been devoted largely to the design and supervision of construction of large bridges, he has developed the vertical lift bridge and a variation of it, the movable deck, and has made a specialty of large movable structures of all kinds.



Mr. Harrington became a member of the American Society of Mechanical Engineers in 1902. He is also a member of the American Society of Civil Engineers, the Engineering Institute of Canada, the Institution of Civil Engineers of Great Britain, the American Railway Engineering Association and the American Society for Testing Materials.

* * *

The use of gas, either illuminating or natural, for preheating in thermit welding should be discouraged, because with this fuel the preheating gate in the mold may become badly burned. In order to pre-heat a section to be welded by the thermit process, it is better to use gasoline or kerosene as a fuel. The flame of these fuels can be regulated so that the preheating gate will be dried out by the heat, but not burned. A rich flame may be used during the early part of the preheating operation without harm, but toward the end care should be taken to see that no excess fuel is used.

# Roughing Bevel Gears and Pinions

By FRANKLIN D. JONES

WHEN bevel gears are required in large numbers, as in the automotive industry, the general practice is to rough out the gears on a machine designed especially for rapid cutting, and then finish these roughly formed teeth on a machine constructed primarily for generating accurate teeth. This practice has two advantages: It increases production because the stocking cuts are made on machines that are very efficient for such work; and the machines used for finishing are not subjected to the strains produced by heavy roughing cuts; consequently, their accuracy is maintained. Several types of Gould & Eberhardt machines designed especially for roughing out bevel gears and pinions are illustrated in Figs. 1 to 6 and in Fig. 8.

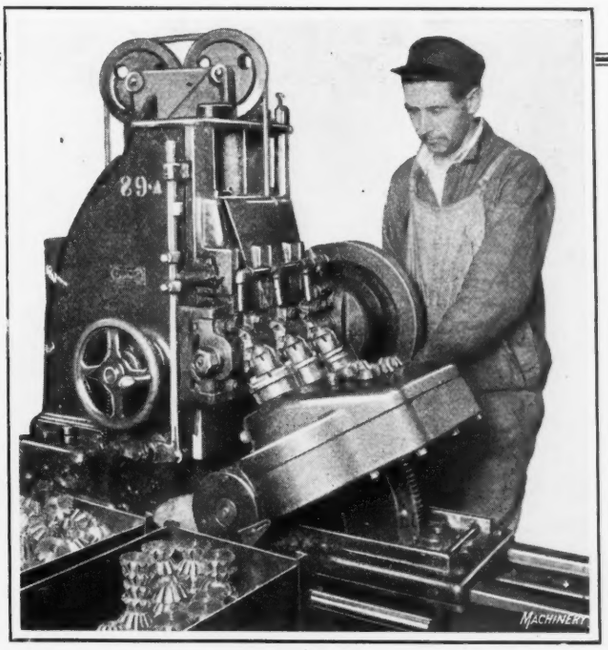



Fig. 1. Roughing Bevel Pinions on a Vertical-cutting Type of Machine equipped with Three Cutters

### Roughing Bevel Gear Pinions on a Multiple Shaper

A multiple type of shaper designed especially for roughing small bevel pinions in large quantities is shown in Fig. 2. This particular machine is used for roughing out the bevel pinions of automobile differentials. Six pinions are cut at a time, the shaper being equipped with six tools and six work-holding spindles, as shown in Fig. 3. The roughing out is done at the rate of fifty-six pinions per hour. The pinions are made of open-hearth steel, and they have twelve teeth and a face width of 13/16 inch. They are indexed after each cutting stroke, and the work-spindles are locked while the tools are at work. The shaft that transmits motion for indexing the work-spindles may be seen in Fig. 2. The tool-head is fed downward automatically by a cam designed to vary the feed according to the position of the tools relative to the blanks. Thus, when the tools are entering blanks, the feeding movement is comparatively rapid, and as the full depth of the cut is approached, the feed is reduced. The work-spindles of this machine are in a fixed position and remain at the same angle, since this is a single-purpose machine designed for use on pinions of one size.

### Multiple-spindle Bevel Gear Roughing Machine

One of the multiple-spindle machines for roughing bevel gears and pinions is shown in Fig. 1. This particular design has an adjustable work-head to permit gears of different sizes and angles to be cut. The machine is a vertical-cutting type, using formed cutters, and it is of a triplex design, three pinions being cut at one time. Since the work-table has angular adjustment and is carried by a slide, adjustable along the horizontal ways of the bed, this machine may be adapted to a variety of gear sizes and is recommended in preference to the non-adjustable design for use where the production of duplicate gears is not on a large enough scale to warrant installing a more special machine.

Fig. 4 shows a machine for cutting four bevel pinions at a time. The work-spindles in this case are located at a fixed angle, since the machine is intended for exclusive use on one angle only. This machine is of the type having

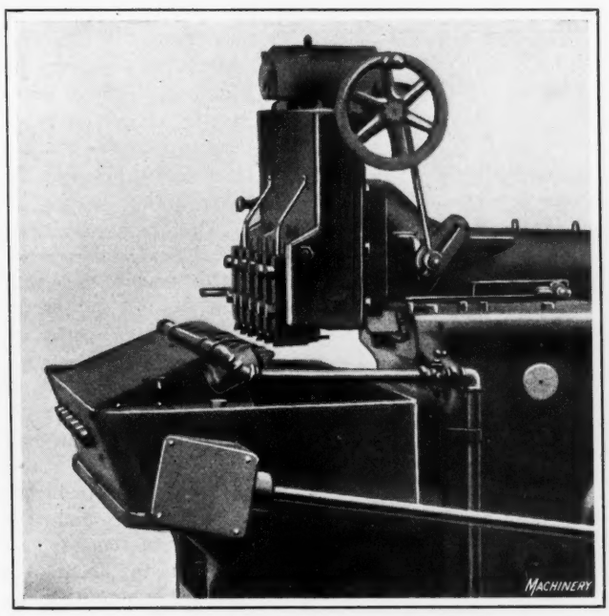



Fig. 2. Multiple Type of Shaper for roughing Bevel Pinions

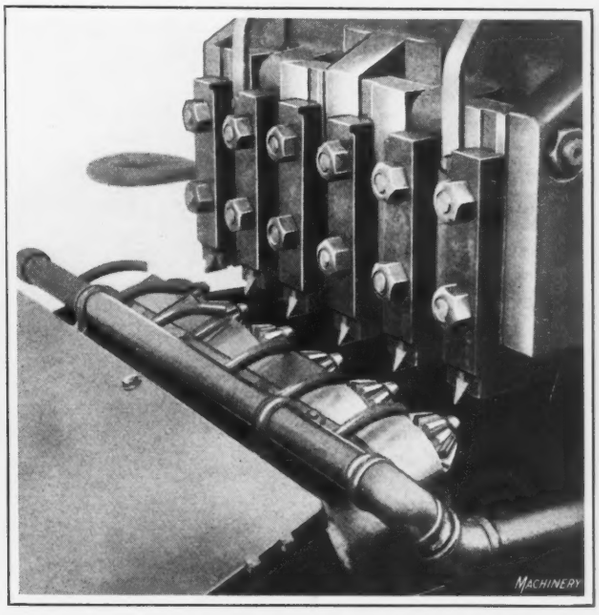



Fig. 3. Detail View of the Six Cutting Tools and Pinions

a revolvable turret, which permits the operator to reload blanks while the four pinions on the opposite side of the turret are being cut. The particular machine illustrated is being used for finishing pinions not requiring the accuracy obtained on a generating type of machine. This fixed-angle turret head type, however, is intended primarily for roughing out bevel pinions.

Another bevel gear roughing machine of the vertical-cutting turret type is shown in Fig. 8. The work-spindles are held at a fixed angle, but point downward, because, in this case the gears have projecting hubs, which prevent their being cut while held in the usual way. Two bevel gears are cut at a time, and the two additional work-spindles on the opposite side of the turret provide a loading position. These gears have twenty-eight teeth of 4 diametral pitch, and are made of 3½ per cent nickel steel. The rate of feed is 6.6 inches per minute, and the production obtained is sixty-one gears in eight hours.

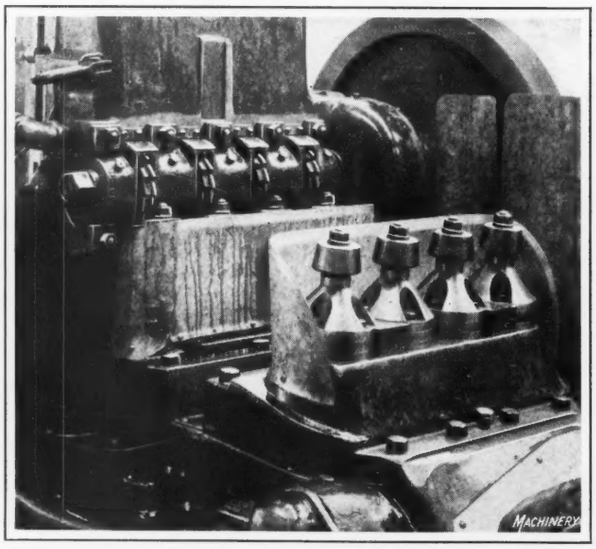


Fig. 4. Machine with Turret and Fixed-angle Work-spindles

designed and built by Gould & Eberhardt for the Ford Motor Co. to give the extremely large production required in roughing out the ring gears of the differential mechanism. The gear blanks are held on an octagonal shaped turret, and three cutters are at work simultaneously, each cutter being in a central position relative to three groups of blanks. These ring gears, for which this machine is used exclusively, have an even number of teeth (forty teeth of 5 pitch) so that each cutter passes from one gear to the next, thus cutting tooth spaces across successive gears as the turret revolves continuously. A slow feeding movement is employed while the gears are being cut, and a much faster movement when the cutters are passing the spaces between the gears.

The turret holds twenty-four gears when fully loaded and they are roughed out at the rate of thirty per hour, or two minutes per gear. The cutters have a speed of 140 feet per minute. The feeding movement of the turret is from 15 to 16 inches per minute, and the rotary motion is increased to about 112 inches per minute when the cutters are passing across the spaces

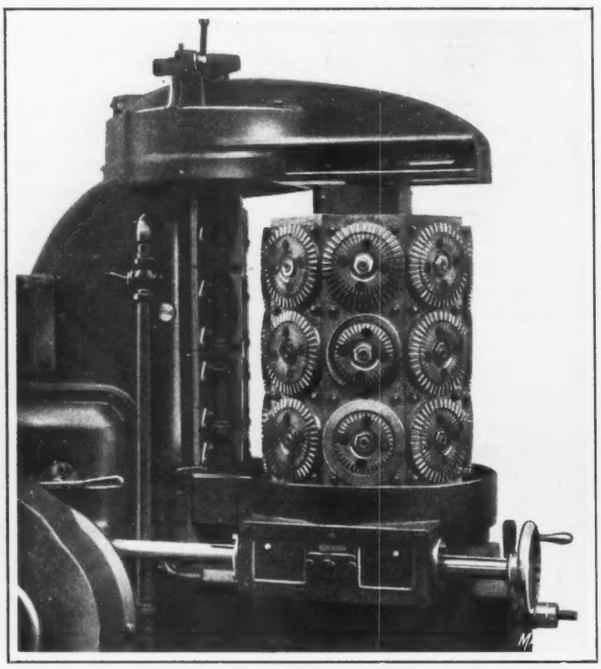


Fig. 5. Special Design of Ring Gear Roughing Machine

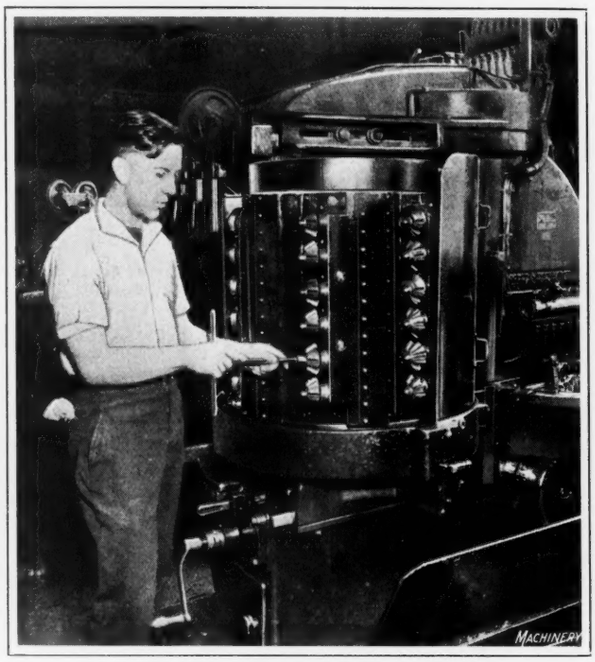


Fig. 6. Another Special Machine for roughing Differential Pinions

### Roughing Bevel Gears on Turret Type Machines

Bevel gear roughing machines of the highly specialized design shown in Fig. 5 were

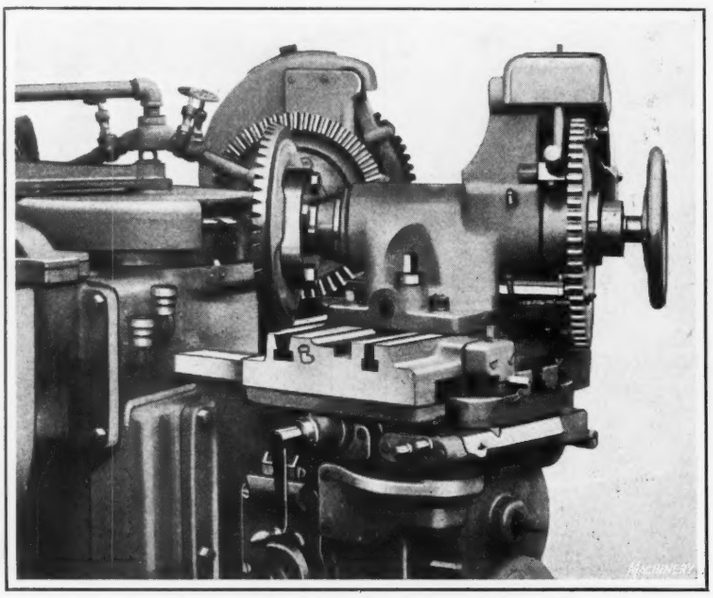


Fig. 7. Roughing Bevel Gears of 4 Diametral Pitch on Triplex Type of Machine

between the rims. The gear blanks are indexed one tooth after each complete revolution of the turret. When starting the machine, the turret is not fully loaded; the operator first places one gear blank in position, the blank being held by a single nut and plate washer. Then, as the turret swings around and one of the cutters starts working on the first blank, another one is placed on the turret, and this loading is continued until the turret is completely filled. By this time the first gear is, as a rule, finished, and it is replaced by an uncut blank. The operator then continues to remove the roughed out gears, and replaces them with plain blanks as the turret revolves continuously.

Another turret type of roughing machine is shown in Fig. 6. This machine is used for roughing the steel differential pinions of Ford tractors. There are six cutters for milling tooth spaces across each blank in whatever vertical row of blanks is in the cutting position. The relatively slow feeding movement of the turret is then accelerated to bring the next vertical row of pinion blanks opposite the cutters. All the spindles are indexed for the next tooth once during each revolution of the turret. As the illustration indicates, the operator removes the roughed out pinions and places new blanks on the work-spindles, so that there is very little idle time. A projecting arm above the turret provides a rigid support for the upper end, which is also true of the machine shown in Fig. 5.

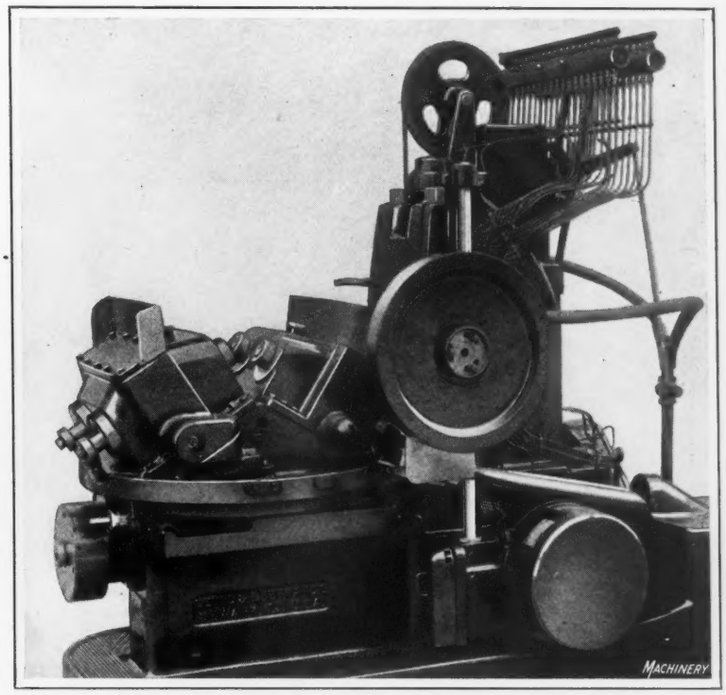



Fig. 8. Bevel Gear Roughing Machine having Special Fixed-angle Turret

### Triplex Type of Bevel Gear Roughing Machine

A special design of bevel gear roughing machine intended for production on a very large scale is shown in Figs. 7 and 9. This machine is a Gleason design, a circular type of cutter head, 20½ inches in diameter, is located centrally relative to the three work-holding spindles. These spindles are mounted on slides providing lateral adjustment and radial feeding movements.

When the machine is at work, each head operates independently. The main slide feeds inward radially until the tooth space is roughed out to the required depth. Then the slide and work-spindle move back far enough for the gear to clear the cutter during the indexing movement. The indexing of each spindle is controlled by a notched plate at the outer end of the spindle. The feeding motion is obtained from a cam which acts through an adjustable cam-lever by means of which the stroke is varied as required by the tooth depth. Graduations on the adjustable cam-lever indicate the length of stroke for different adjustments. After all the teeth have been roughed out, the feeding movement for that particular head is automatically disengaged. The operator then replaces the roughed out gear with an uncut blank, while the blanks mounted on the other work-spindles are being cut.

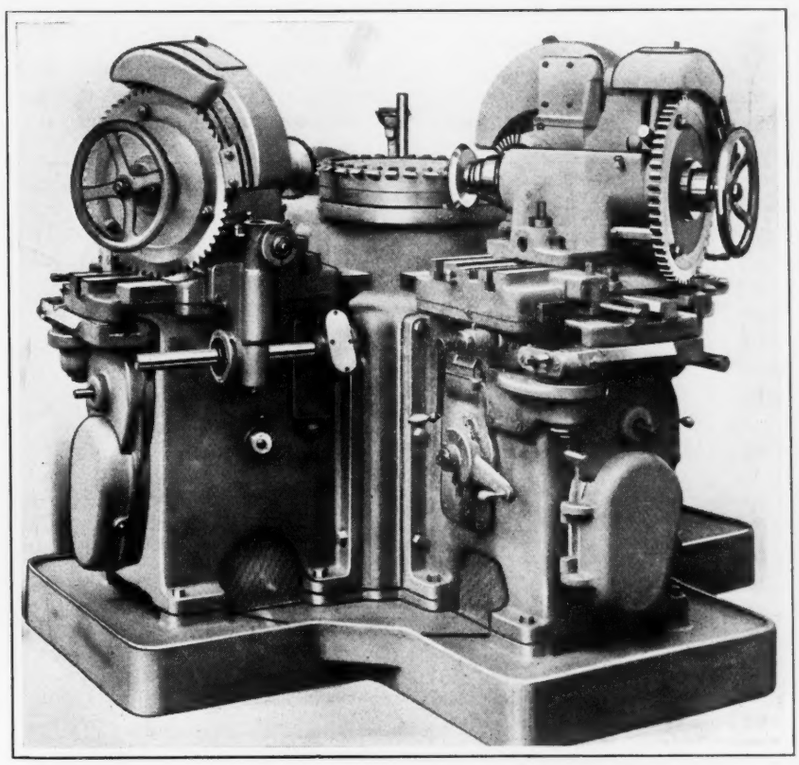


Fig. 9. Triplex Type of Bevel Gear Roughing Machine—Cutter Guard removed

This machine may be used for roughing out gear and pinion blanks simultaneously. The heads for holding pinions incline more from a radial position than the heads for holding gears, in order to allow for the relatively small pitch cone angles of the pinions and enable both gears and pinions to be held in the proper positions relative to the cutter-head. The angular position of each work-spindle is fixed, all the adjustments being obtained by the radial and lateral slides previously referred to.

When the machine is first set up, the blank is located relative to the cutter-head by means of a gage, the base of which fits into a recess in the center of the cutter-head. This gage is located by the engagement of a tongue with a cross-slot at the center of the cutter-head. Three sets of zero marks are provided for locating this cross-slot and the gage for any one of the three work-spindles. For example, if the No. 3 work-head is being adjusted, the No. 3 graduation on the periphery of the cutter-head is set opposite the No. 3 pointer below the cutter-head. The cutter-spindle is driven through spiral bevel gearing, the gear being bolted just beneath the flange of the main spindle on which the cutter-head is mounted. At the lower end of this

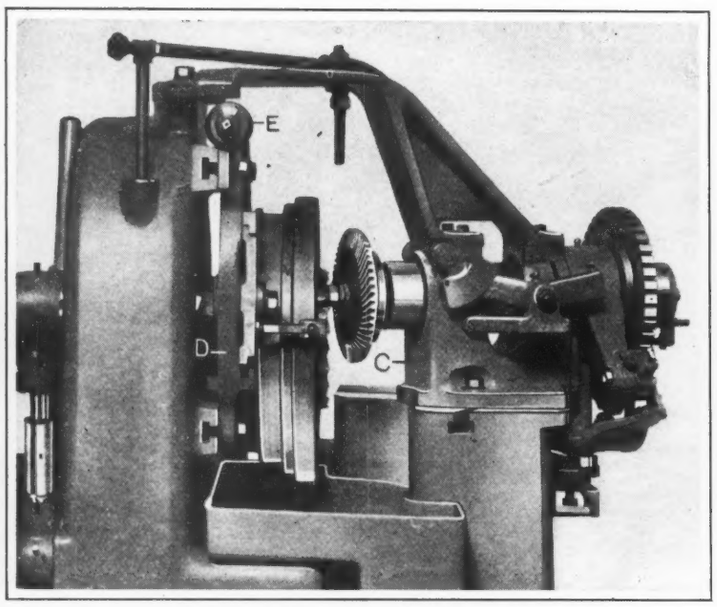



Fig. 10. Machine for roughing Spiral Bevel Gears

main spindle, motion is transmitted to each of the work-heads through bevel gearing and three horizontal shafts connected with the feeding and indexing mechanism by additional shafts and gearing.

This machine may be used for roughing out gears having pitch diameters up to 16 inches and a maximum diametral pitch of 3. The cutter-head operates at a speed of 100 feet per minute. The feeding movement of the work-slide may be varied from 0.200 inch for the fine pitches to 0.950 inch for the coarse pitches. The rate of feed may be varied from five to forty-five seconds per tooth. A general idea as to the rate of production on this machine may be obtained from the following example. When roughing out differential pinions and gears having twelve and twenty-four teeth, respectively, of 5–7 pitch and made of 3½ per cent nickel steel, the work was done at the rate of eight seconds per tooth. In this instance two work-heads were used for the gears and one for the pinions, since the latter require a much shorter time for roughing.

### Roughing Spiral Bevel Gears

Spiral bevel gears can be roughed out on the same generator that is used for finishing, but it is advisable to do the roughing or stocking out on a machine designed especially for that purpose, assuming that gear-cutting is done on a scale large enough to warrant employing a special roughing machine. Very small spiral bevel gears, such, for example, as are cut on the Gleason 4-inch machine, are finished direct from the solid, because a preliminary roughing operation is unnecessary for these small pitches. Opposite sides of one of the Gleason spiral bevel gear roughing machines are shown in Figs. 10 and 11.

This machine does not require a generating motion like the machine for roughing spiral bevel pinions. The cutter-spindle receives an endwise feeding movement, as the cutter-head mills tooth spaces of the required depth. After each tooth space is roughed out, the cutter withdraws to clear the work for indexing. The endwise motion of the cutter-spindle is derived from a cam on the cutter-spindle sleeve. This cam is driven through change-gears, which regulate the rate of feed according to the material and pitch. The cutter-head is of circular form, and is similar to the type used on the finishing machine. The machine is automatic, and it may be used for roughing either right- or left-hand gears. When a left-hand gear is being roughed, the center of the cutter is below the center of the work, as shown in the illustrations, whereas for a right-hand gear the center of the cutter is above that of the work.

The arrangement of the indexing mechanism is shown quite clearly in Fig. 11. The motion is transmitted from a cam enclosed within the main housing, which actuates the segment-shaped slide *A*, through a lever and connecting link. As this slide moves in its supports, a segment gear, through a pinion and vertical shaft, transmits motion to the indexing mechanism. The plate *B*, which has as many notches as there are teeth in the gear to be cut, is engaged by a locating pawl. When this pawl is withdrawn for indexing, the locating plate is acted upon by another pawl, which shifts the work-spindle the required amount.

### Selection of Cutter-head and Adjustment of Cutter-spindle and Work-holding Head

The cutter used for roughing should preferably be of the same hand as the gear to be cut. For instance, the machine shown in Figs. 10 and 11 is set up for cutting a left-hand gear and the cutter is also left-hand, since it rotates to the left or counter-clockwise, as seen from the rear side. The cutting blades conform to the pressure angle of the gear (14½ or 20 degrees).

What is known as the "point width" must also be considered in selecting a cutter. The point width depends upon the pitch, face, cone distance, thickness of tooth, and spiral angle. It is obtained by calculating the normal width at the bottom of the tooth space at the small end and subtracting from this an allowance for the finishing cut. The nearest standard point width is then selected. When a left-hand cutter is used, an intermediate gear is employed so that the feed works will rotate in the same direction as when a right-hand cutter is used.

Before adjusting the cutter-spindle endwise, the feed-cam is set so that the cutter-spindle is in its extreme outer position, as determined by means of a gage. Another gage which rests on two blades on both sides of the cutter-head, is then used to determine the endwise adjustment, which is made by shifting the position of the roller that engages the cam on the work-spindle sleeve.

The work-holding head *C* is set to the root angle of the gear by means of graduations on the edge of the base. Before adjusting the work-spindle longitudinally, it is

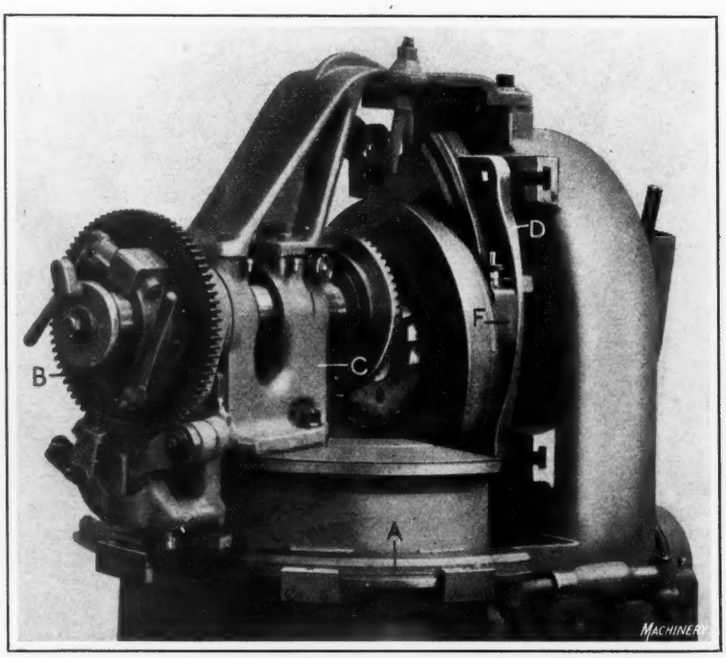



Fig. 11. Another View of the Spiral Bevel Gear Rougher

necessary to rotate the feed-cam until the cutter-spindle is in its extreme backward position. The work-spindle is then adjusted until the distance from the crown (extreme outer edge) of the gear blank to the plane in which the points of the cutter blades lie is equal to the throw of the feed-cam which gives the cutter-spindle its endwise movement. The work-spindle is next moved forward an additional amount equal to the full depth of the tooth, divided by the sine of the root angle of the gear to be cut. A rack and pinion at the outer end of the work-spindle is used for making these adjustments. The second adjustment is regulated by first setting a stop-screw the same distance from a lug as the gear is to be moved forward. This stop is then used for setting the work-spindle for all succeeding gears of the same kind.

### Setting the Cutter-spindle Carriage and Cross-slide

The cutter is supported by a carriage which may be swiveled about an axis coinciding with the horizontal center line of the machine (as indicated in the diagram, Fig. 14). The swiveling carriage and the cutter-head are supported by a slide *D* (see also Figs. 10 and 11) which may be adjusted laterally for varying the distance between the center of the cutter and the vertical center line of the machine. These angular and lateral adjustments determine the angle of spiral cut on the gear, which must be the same as the angle decided upon for finish-cutting. The adjustments are not the same as on the finishing machine, but they should give the same angle. The crosswise adjustment of slide *D* is obtained by means of a screw in conjunction with a scale and graduated dial *E* (Fig. 10) reading to 0.001 inch. A worm at *F* (Fig. 11) and a segment provide for the angular adjustment, one turn of the worm being equal to one degree, and one division on the worm collar equaling one minute. The crosswise adjustment equals the sum of dimensions $x$ and $y$, Fig. 14.

$x$ = Cone distance — (Face ÷ 2) — (6 × spiral angle)

$y = 13 \times (1 - \cos a)$

The angular position of the cutter carriage is determined as follows:

$$\text{Sin } a = \frac{6 \times \cos \text{ spiral angle}}{13}$$

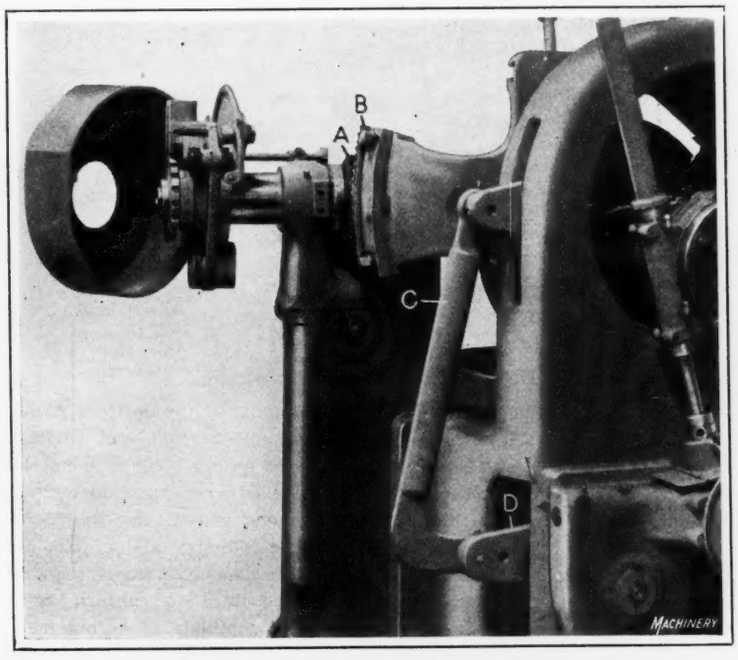



Fig. 13. Rear View of Spiral Pinion Rougher

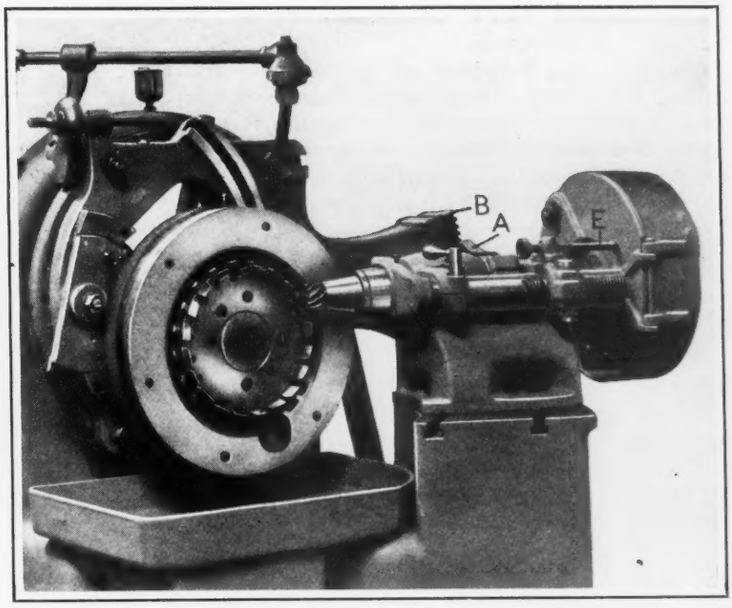



Fig. 12. Machine used for roughing Spiral Bevel Pinions

When the cutter-spindle carriage is shifted from the upper position for cutting right hand gears, to the lower position for left-hand gears, or vice versa, the relation between the cam controlling the indexing movement and the feed-cam for the cutter-spindle must be changed, it being necessary to re-time the action of the cams. Cutter-spindle feed-cams are made with different amounts of throw to suit the tooth depth of the gears to be cut.

### Roughing Spiral Bevel Pinions

The machine used for roughing spiral bevel pinions is similar in some respects to the gear rougher, the chief difference being that the former operates with a generating motion. This is required for pinions, because the teeth are not nearly so straight lengthwise as gear teeth, owing to the fact that they are formed around a much smaller pitch cone as compared with the gear, and consequently have much more twist or curvature. For this reason the pinion and cutter must be rolled together to obtain roughed out teeth conforming more closely to the final shape required, than would be possible without a generating motion. In Figs. 12 and 13 are shown front and rear views, respectively, of a Gleason machine for roughing spiral bevel pinions.

### Generating and Indexing Movements

The generating movement is applied to both the cutter-head and the work. The relative movements of the work-spindle and the cutter head are controlled by a gear segment *A* attached to the work-spindle sleeve and meshing with a crown gear segment *B*. Segment *A* has the same pitch cone angle as the gear to be cut. The crown gear segment is secured to an arm projecting from the frame or drum supporting the cutter-spindle carriage and cross-slide. This frame, which is enclosed within the upper part of the machine column, is given an oscillating movement by a cam located within the base of the machine. Connection with the cam is made through link *C* and lever *D* (Fig. 13), and provision is made for shifting the link connection at the lower end for varying the amount of rolling or generating motion. The extent of this generating movement depends upon the ratio of the gear and pinion to be cut, the movement decreasing as the ratio increases. The approximate rolling motion for different gear ratios is as follows: For ratios from 6 : 1 to

4 : 1, 15 degrees; from 4 : 1 to 3 : 1, 20 degrees; and from 3 : 1 to 1 : 1, 25 degrees.

One tooth space is roughed out during the upward rolling motion, and the pinion is indexed for cutting the next tooth space during the downward movement. This indexing motion is derived from the generating motion of the work-spindle. The indexing mechanism is located at the outer end of the work-spindle and may be seen in Fig. 13; in this illustration the hinged cover has been swung outward to expose the indexing mechanism. The index-plate which is engaged by the locating pawl, has as many notches as there are teeth to be cut.

### Adjustments of Cutter and Work

The cutter should preferably be of the same hand as the spiral on the gear; consequently, it will be opposite that of the pinion. Although a cutter of the same hand can be used for both gear and pinion, it is usually necessary to have separate cutters, as a greater point width of cutter is required for the gear than for the pinion. A cam mounted on the cutter-spindle sleeve gives the cutter a positive feeding movement, the same as on the gear rougher, and a feed-cam is used having a throw corresponding to the tooth depth. The cutter-spindle must be adjusted endwise, so that the points of the cutter blades are in the same plane as the apex of the pitch cone of the pinion. This adjustment is made by means of a screw controlling the position of a feed-cam roller, and it is regulated by means of a gage. The formulas for determining the angular position of the cutter-spindle carriage and the lateral position of the cross-slide are the same as those used for the gear rougher. The angular adjustment is also made by means of a worm and segment, and the cross adjustment by means of a screw in conjunction with a scale and a graduated dial, which is similar to the arrangement on the gear rougher.

The keyways in the pinion blanks should be cut before the roughing operation, and an arbor having a key should be used. By also using a keyed arbor when the pinions are finished on another machine, all pinions will be held in the same position relative to the cutter, and it will not be necessary to set each pinion to divide the stock left for finishing. The head carrying the work-spindle is set in accordance

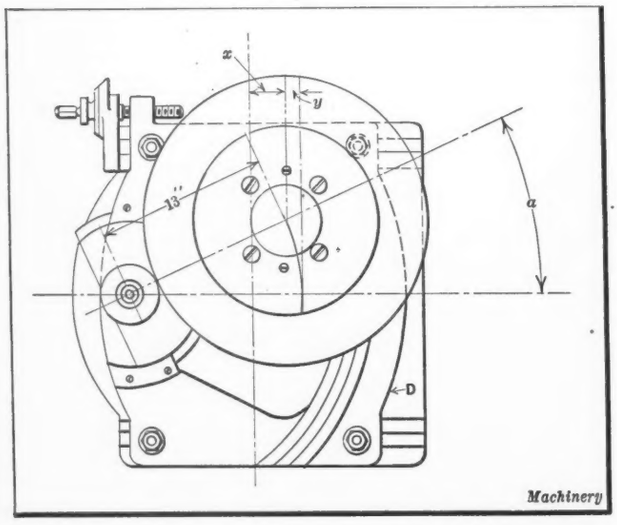



Fig. 14. Diagram showing Angular and Lateral Adjustments of Cutter-head on Spiral Bevel Gear Rougher

with the root angle of the pinion. The pinion blank is set at the right distance from the center of the machine by means of a scale and stop screw *E*, Fig. 12. The graduations represent distances from the nose of the spindle to the center of the machine. The time required for roughing out a tooth space may vary from a minimum of 18 seconds to a maximum of 72 seconds. The cutting speed is 106 feet per minute.

## A GAGE-MAKER'S PROBLEM

By W. G. HOLMES

The problem dealt with in this article was encountered in the production of a certain gage. As the solution given is applicable to problems that occasionally arise in gage work, it should be of interest to gage designers and gage-makers. In the problem we have an arc of radius $r$, which cuts the corner of a right angle $UVW$ in such a manner that the vertical line $WV$ is cut at point $H$, and the horizontal line $UV$ at point $G$, dimensions $A$ and $B$ being known.

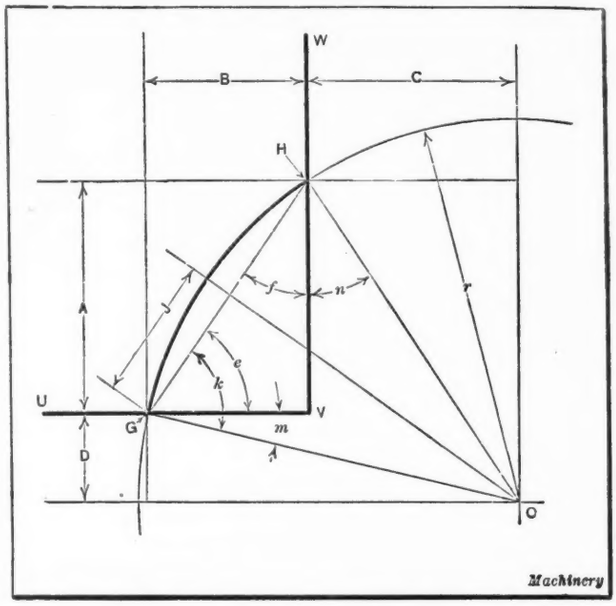



Diagram used in solving Gage-making Problem

In order to determine the location of center $O$ with respect to the sides of right angle $UVW$, it is necessary to find dimensions $D$ and $C$.

The given dimensions are as follows:

$A$ = amount cut off by arc on vertical line $WV$;

$B$ = amount cut off by arc on the horizontal line $UV$; and

$r$ = radius of arc.

With these dimensions given it is desired to find the horizontal distance $C$ from point $H$ to the center line passing through point $O$, and the vertical distance $D$ from point $G$ to the horizontal center line passing through point $O$.

By trigonometry

$$\text{Tan } e = \frac{A}{B} \text{ and cot } f = \frac{A}{B}$$

and by geometry

$$e + f = 90 \text{ degrees and } J = \tfrac{1}{2}\sqrt{A^2 + B^2}$$

Now

$$\cos k = \frac{J}{r};\quad m = k - e;\quad \text{and}\quad n = k - f$$

Then

$$D = r \sin m \quad \text{and} \quad C = r \sin n$$

* * *

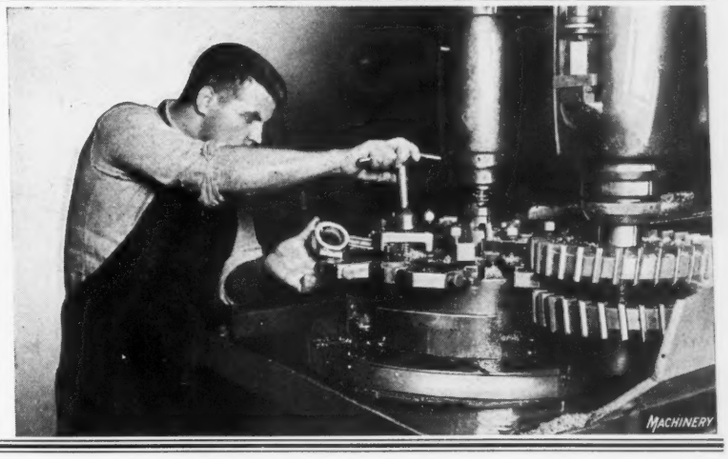
## ENFORCEMENT OF SAFETY CODES

The American Engineering Standards Committee, 29 W. 39th St., New York City, has decided that clauses relating to legal penalties or to methods of enforcement will not be included in the safety codes approved by the committee. It is the opinion, both of the men engaged in the standardization of safety appliances in the industry and of officials having to do with the laws of enforcement of safety requirements, that legal penalties for failure to conform with established state safety codes and methods of enforcement can best be decided by each state for itself.

# Making Wills Sainte Claire Connecting-rods

**Methods Employed in the Plant of the Taft-Peirce Manufacturing Company, Woonsocket, R. I., for Machining High-grade Automobile Connecting-rods—Second of Two Articles**

By FRED R. DANIELS



IN the first installment of this article, published in November MACHINERY, a number of milling operations employed in machining Wills Sainte Claire connecting-rods were described, together with the special equipment used. In the present article the manufacturing procedure will be continued, and all important information concerning the machining operations required in completing the manufacturing process will be given.

### Machining the Cap-screw Holes

The set-up of the machine used for drilling and reaming the cap-screw holes in the forked style of connecting-rods is illustrated in Fig. 11 and the set-up for the plain style of connecting-rod is shown in Fig. 12, the equipment used in each case being a Pratt & Whitney multiple-spindle drilling machine and indexing fixtures. The fixture illustrated in Fig. 11 holds six forked rods, arranged in three pairs. Four 15-64-inch drills and four 0.247-inch reamers are at work on one pair while a similar group of tools is working on a second pair. The arrangement is such that with each indexing movement two finished rods are produced, which are replaced with two fresh rods at the loading position. The corresponding operation on the plain rods, shown in Fig. 12, is performed on a machine that has been partially redesigned to suit the requirements. The arrangement shown is the result of an effort to increase production by the use of two indexing fixtures, permanently attached to the table of this machine. Each of these fixtures has provision for three connecting-rods, so that by using two at a time, practically the same production is realized as with the equipment used for the forked rods.

Fig. 13 shows the method of mounting these fixtures on the drilling machine table. Two bridge irons are bolted to the base on which the fixtures are attached; these provide a support for the upper end of each fixture and also carry the drill and reamer bushings. Each fixture is operated independently, the index-pin being moved upward by a handle. This handle operates a stud in hole *A* at the base of the fixture to withdraw the index-pin *B* from the bushing in the turret and permit the fixture to be indexed through 120 degrees. During this movement a coil spring forces the end of the index-pin against the under side of the fixture until it snaps into the next indexing hole. The position of the work and the elongated locating pin *C* for the piston-pin hole, which has been used in previously mentioned fixtures, are also shown in this illustration.

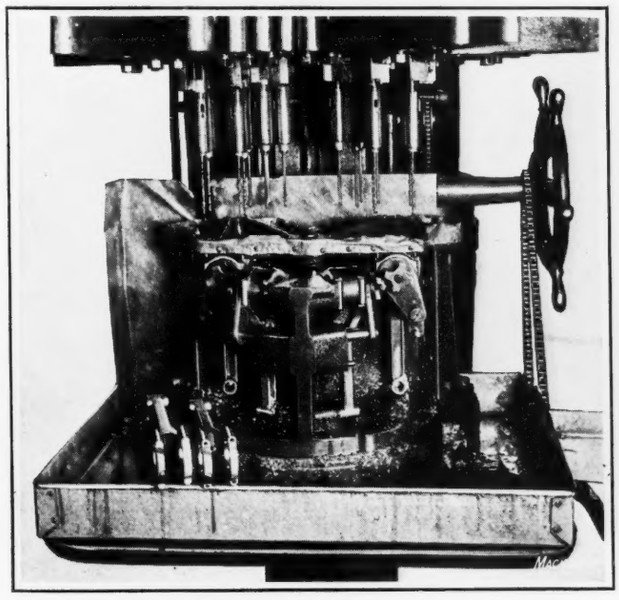


Fig. 11. Multiple-spindle Drilling Machine set up for drilling and reaming Bolt Holes in Forked Rods

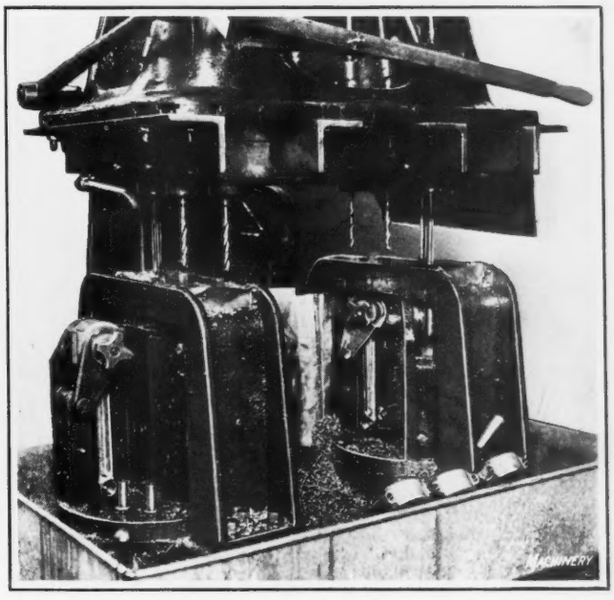


Fig. 12. Machine and Fixtures used for drilling and reaming Bolt Holes in Plain Connecting-rods

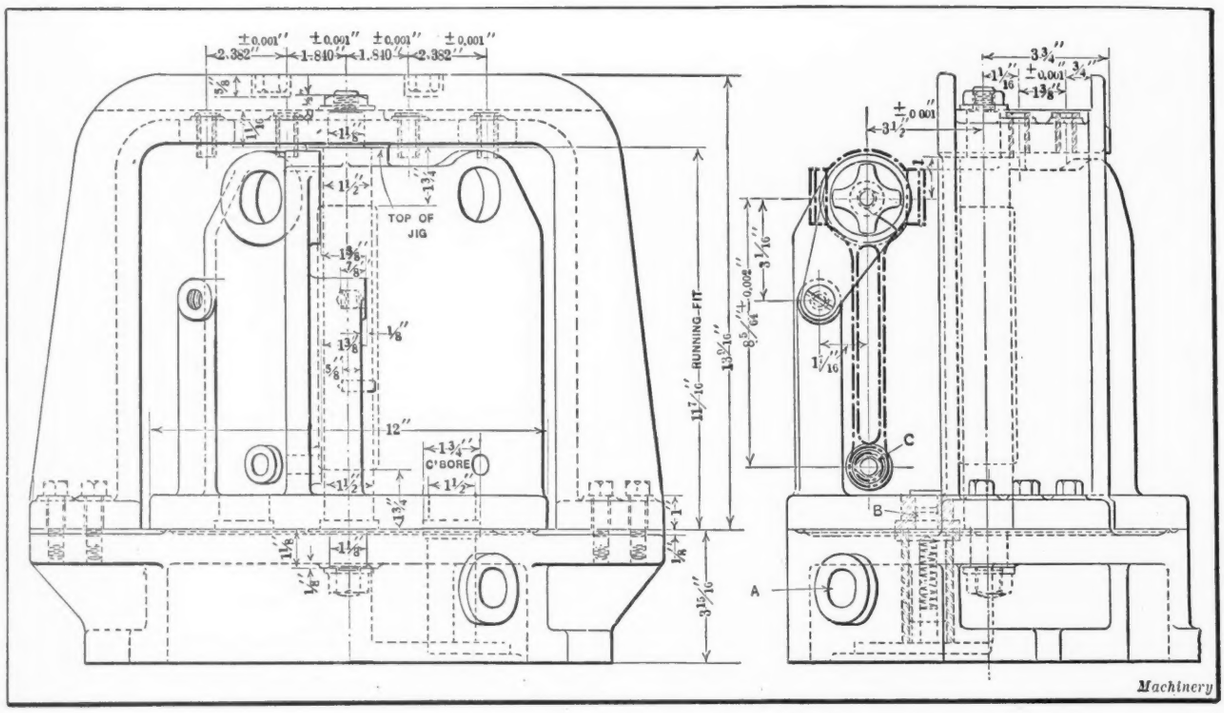



Fig. 13. Method of attaching Two Indexing Fixtures to Drilling Machine Table

In order to establish an unchangeable position for the drill and reamer spindles, it has been found advantageous to equip the machine with two special four spindle multiple heads. The method of attaching these to the under side of the spindle housing is indicated in Fig. 12, and the heads are shown in detail in Fig. 14. Two angle-irons are bolted to the under side of the spindle housing of the machine to form bolting surfaces for attaching these special heads, one being located in the correct position for each indexing fixture. The tendency of the drills to change their center distance slightly during a prolonged run has been entirely eliminated by this arrangement of the drilling machine. When it is realized that the maximum amount of run-out permissible on these cap-screw holes in 0.008 inch, it will be seen that absolutely accurate center location must be maintained and a substantial work-holding medium provided.

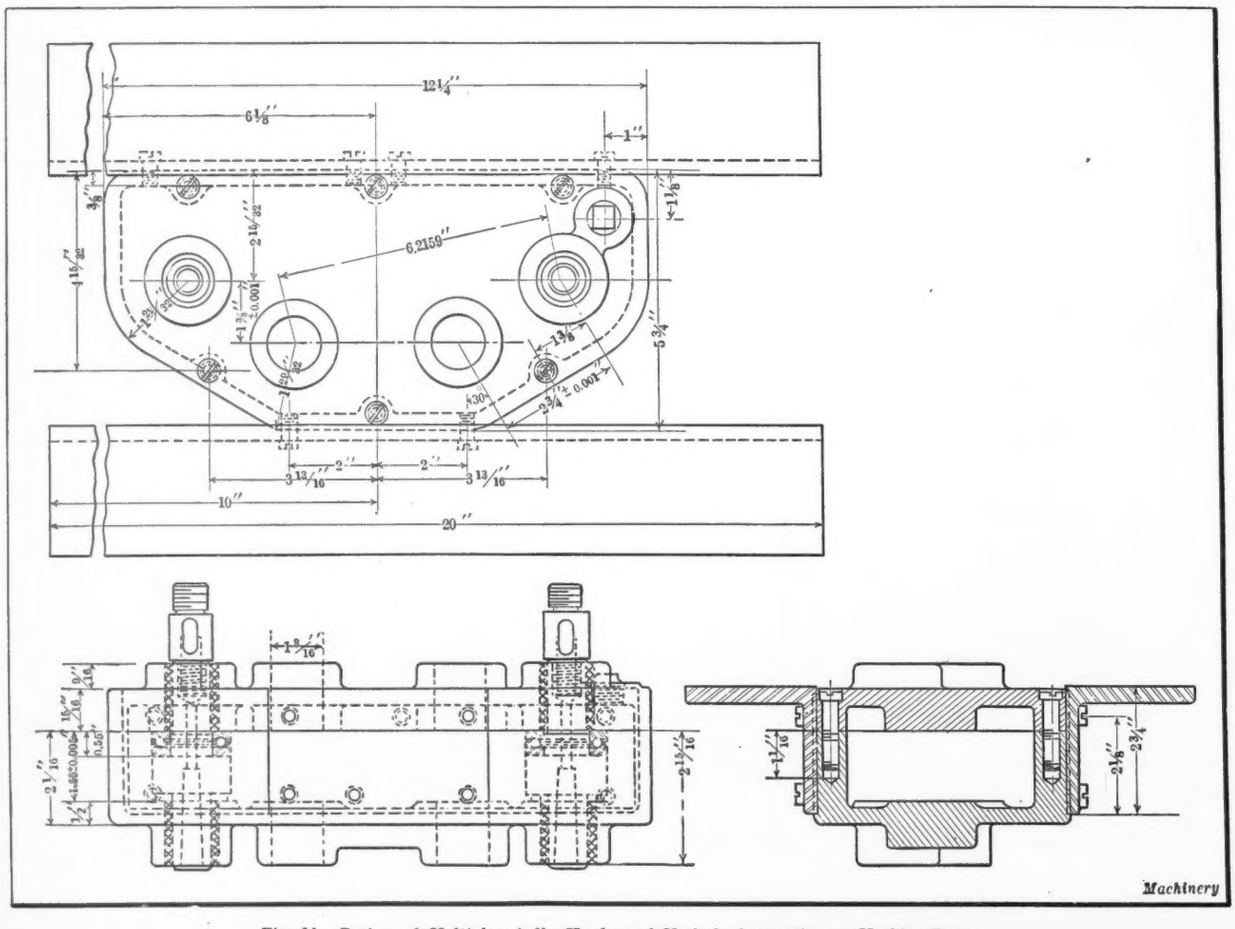



Fig. 14. Design of Multiple-spindle Heads and Method of mounting on Machine Frame

### Grinding the Fitting Surfaces of the Cap and the Rod

After the bolt holes have been drilled and reamed on the machines described, they are hand-reamed to size, and the cap part and rod are then marked in pairs preparatory to being cut apart. A saw ⅛ inch wide, which is used for the latter operation, is mounted on an arbor with two straddle milling cutters, separated by collars of proper width so as to simultaneously mill seats for the bolt heads. This is done on a No. 1½ Brown & Sharpe milling machine.

A Pratt & Whitney vertical surface grinding machine is employed for grinding the fitting surfaces of the cap and bearing for both styles of rods. A Norton 38-30 grade H wheel and a multiple fixture for holding eight rods and their caps are used. The work is so arranged in the fixture as to keep the cap or caps of each rod with that rod and grind them together in one clamping unit of the fixture. The obvious advantage of this is to maintain the alignment of bolt holes and finished boss faces, so carefully obtained in the earlier machine work. The grinding wheel speed is 1100 revolutions per minute. After grinding, the caps and rods are assembled, and are kept together throughout the concluding operations.

The fixture used for grinding the forked rods is illustrated in Fig. 15, two clamping units only being shown. The position of the caps and rods is indicated by heavy dot-and-dash lines. The equalizing clamping medium is worthy of special mention, principally because it is controlled entirely by the operation of one knob secured to stud *A*. Turning this knob forces bar *B* forward and causes the two clamps *C* to hold the four caps (two for each rod) firmly against the steel strips that are set into the upright part of the cast-iron base. The clamps each have a round-point steel insert against which bar *B* is forced, and the yoke part of the clamps has lugs to engage the caps, so that they may be held with equalized pressure. By this arrangement the rods are quickly clamped.

Continued turning of the knob causes the hinged link *D* to draw bar *E* toward it, carrying the two tie-rods *F*, thus causing heads *G* to seat against the inside of one prong of each fork and clamp the fork to the steel face on this side of the fixture. The tie-rods are drilled at the end for a spring pin. After the connecting-rods have been clamped in the manner described, the spring pins may be released by means of thumb screws *H*, to allow the floating clamps *J* which they carry, to engage the inside of the other prong. When this has occurred, the thumb-screws are tightened to hold the clamps in place during the grinding operation, thus preventing the fork from springing out of parallel under the pressure of the grinding wheel. There are two pins in each clamp *J*, which engage the bore of the connecting-rod bearing and locate these floating clamps relative to the bore. Heads *G* are movable, as they must be swung through 180 degrees in order to permit the rods to pass by them when removing the work after grinding. It is also necessary to depress clamps *J* and lock them in this position with the thumb-screws before the rods can be removed. The entire arrangement constitutes a flexible mechanism by means of which an even clamping tension can be secured on two rods and four caps with a minimum of effort and time.

A micrometer gage is used to check the work while it is in the fixture, gaging from the

Fig. 16. Inspecting the Parallelism of the Piston-pin Hole with the Cap Bearing Surfaces

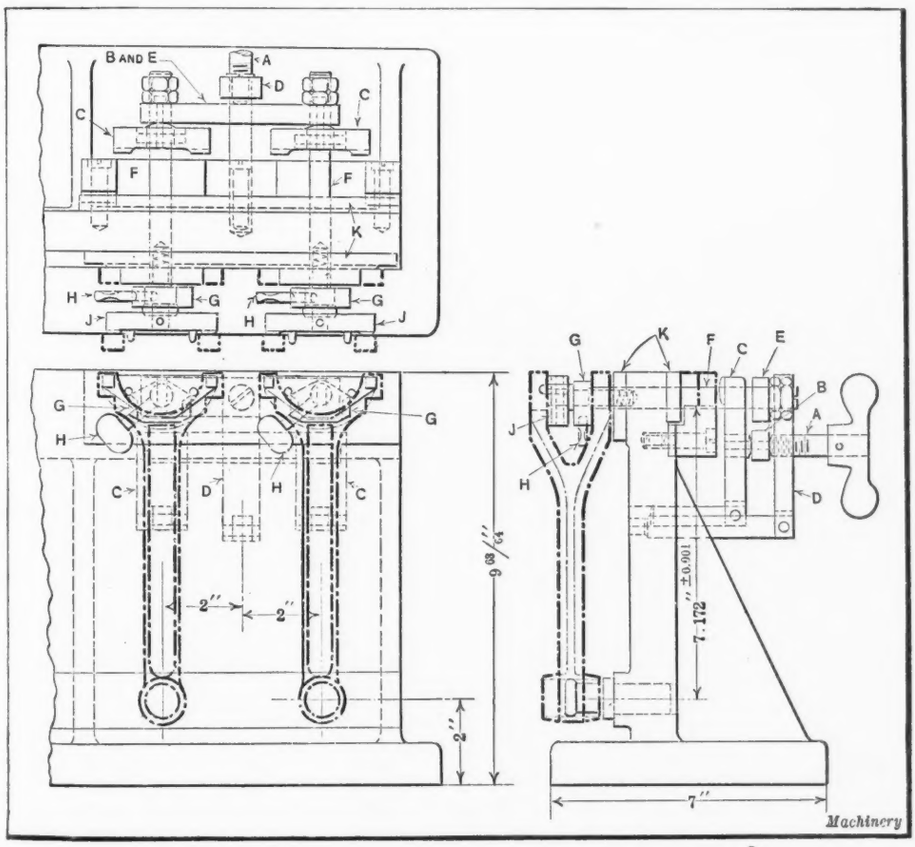



Fig. 15. Fixture used in grinding Bearing Surfaces of Caps and Forked Rods

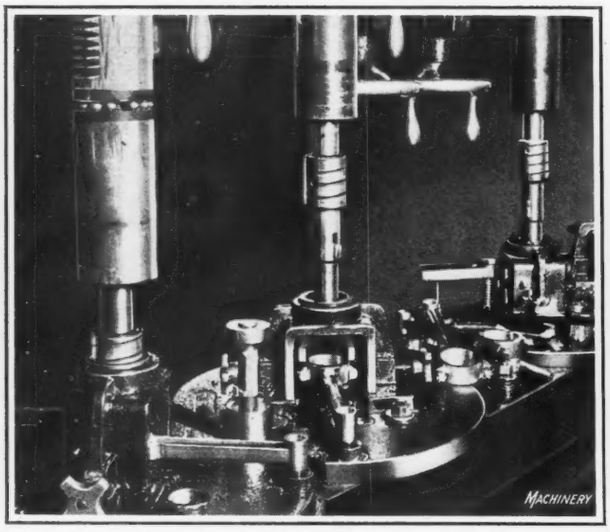



Fig. 17. Boring Crankpin Holes after assembling Caps

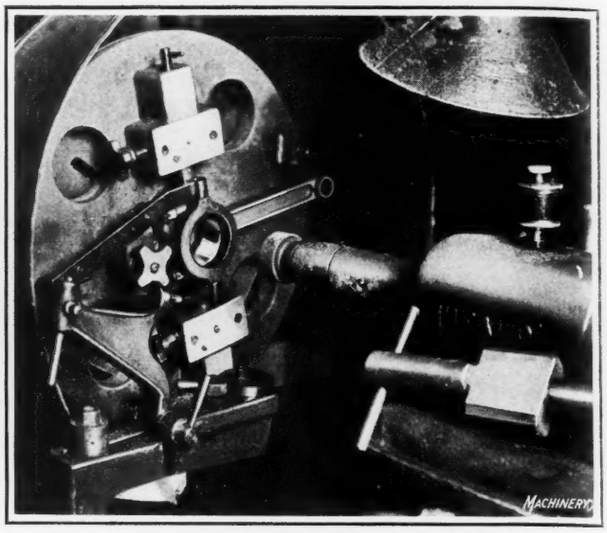



Fig. 18. Grinding Crankpin Holes in Forked Rods

steel strips or parallels *K*. The distance from the piston-pin hole to the ground surfaces at the cap joint, on which there is a tolerance of but 0.004 inch, is also gaged and the parallelism checked, by the use of a surface plate, indicator gage, and a test block. This inspecting operation is illustrated in Fig. 16 which shows the equipment mentioned and the method of using the indicator, with the ground surfaces of the cap bearings resting on the surface plate and a plug inserted in the piston-pin hole.

### Major Operations after Assembling Caps

The rods, with the caps assembled, are then ground on the parallel surfaces of the crankpin bearing bosses. One cut is taken on each side of the plain rods, but two cuts are necessary on the forked rods to compensate for their tendency to spring. For this work a Blanchard surface grinder is used. When grinding plain rods, the magnetic chuck is provided with an annular plate equal in thickness to one-half the difference in width of the plain and forked rod crankpin bosses. This plate is used under the crankpin end of the plain rods. In other respects, the set-up for both rods is the same.

Sixteen rods are arranged radially on the grinder chuck at one time. A Norton 38-30 grade H wheel is used, running at 850 revolutions per minute. For the plain rods, the wheel feed is 0.0004 inch per revolution; for the forked rods, 0.0005 inch for roughing, and 0.0002 inch for finishing. It should be stated that the second or finish-grinding operation on the forked rod bosses does not occur until after the gap has been semi-finish-milled (as described in detail in the first installment), and in finish-milling the gap which follows the finish-grinding of the sides, the work is located from these ground surfaces.

The grinding of the crankpin boss on the plain rod, and the corresponding rough-grinding operation on the forked rod are followed by boring the large hole, to correct the elliptic shape caused by cutting off the caps. For the forked rods, this occurs before either the gap is finished or the faces of the large boss are finish-ground, although these two operations were mentioned in conjunction with the grinding of the bosses on the plain rods.

Fig. 17 illustrates the type of equipment used in boring both rods. This is a Foote-Burt multiple-spindle drilling machine, on the table of which special boring fixtures are permanently attached. Davis piloted boring-bars are used. In locating the connecting-rods for boring, a bushing having external lugs to fit the major diameter of the elliptical hole, is first placed in the hole. The boring-bar pilot is then employed to position the crankpin end of the rod correctly, the rod itself being free to swing on a stud at the piston-pin end. When thus located, the capstan wheels on each side of the fixture are turned to retain this setting, and the bushing is removed. A spacing collar is interposed between the prongs when boring the forked rods. The cutting speed of the boring-bar is 80 feet per minute, and the feed is 0.005 inch per revolution.

The plain rod is next hollow-milled on each side of the large boss to produce the 10-degree taper. (See Fig. 1 of the first installment in November MACHINERY.) This operation also removes a small irregular projection left at the junction of the H-section and the boss. The work is done on a Defiance drilling machine. At intervals during the various machining operations, it is necessary to burr, straighten, or sand-blast the rods. These operations do not require description, but they are of vital importance in the manufacturing procedure. In sand-blasting, the finish-bored holes are protected by wooden covers, and a Pangborn sand-blasting machine is employed.

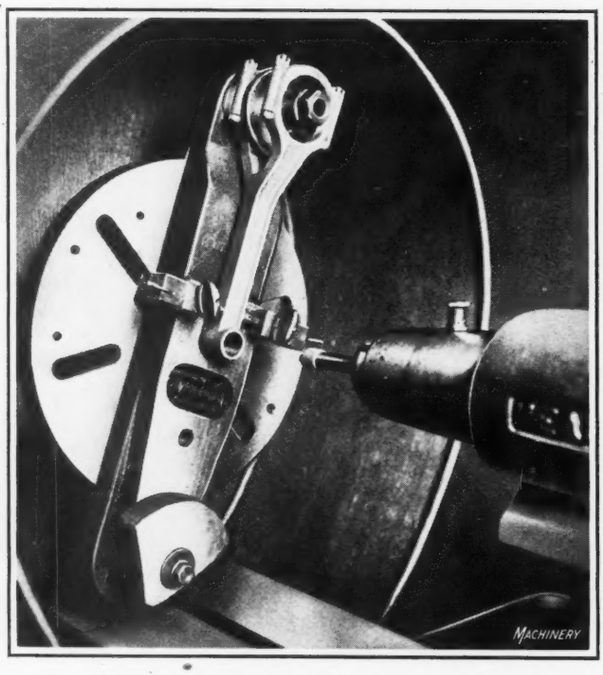



Fig. 19. Grinding Piston-pin Holes in Forked Rods

### Grinding the Holes, and Final Operations

The grinding of the crankpin and piston-pin holes in the forked rods are illustrated in Figs. 18 and 19, respectively. For the large hole, a No. 2 Brown & Sharpe cylindrical grinding machine

equipped with a Heald grinding head, is used, on the workhead of which is mounted an aluminum faceplate to which the clamping arrangement is attached. The boss is centered by a special plug shown lying on the wheel-head base, and two spring pins, carried in blocks opposite the bolt-hole bosses. It is secured by turning a knob which forces a circular clamp against the outer finished face of the large boss. This ring-shaped clamp is free to seat itself evenly on the work because of its trunnion-bearing mounting. The diameter of this hole is held to a tolerance of 0.0005 inch, and limit plug gages are used for checking the work. A 38-60 grade K Norton wheel, revolving at 8000 revolutions per minute is employed. The feed is 0.00025 inch per revolution of the spindle.

In locating the work for grinding the piston-pin hole (Fig. 19), the ground crankpin hole is placed over a ground steel plug, and clamped by a screw and large washer which engages the inner prong. The fixture also has two side clamps to hold the rod after it has been positioned radially by means of a plug which fits the bored piston-pin hole and enters a bushing in the fixture. The fixture is counterbalanced to take care of the weight of the overhanging rod. The wheel used is a Norton 38-60 grade K. The wheel speed is 12,000 revolutions per minute and the feed 0.00025 inch per revolution. The data for grinding the plain rods are substantially the same as just described.

At this stage of manufacture, the forked rod caps are disassembled and two 3/16-inch pin holes drilled and reamed in the rod bearing. (See Fig. 2 of first installment.) The caps are replaced after dutch-pins are driven in these holes, and then both sides of each prong are counterbored on a Prentice drilling machine, using a bridge-iron fixture. A fly cutter is used in the boring-bar for the inside counterbored holes so that it can be passed through the crankpin hole and then fed first up for one counterbore and then down for the other. The main object of this operation is to remove any bulge caused by driving in the 3/16-inch pins, which are rather close to the edge of the hole. Stops under the bridge-iron limit the feeding movement. A two-bladed bar is used for machining the outer counterbores.

The piston-pin bushings are then assembled on a Greenerd arbor press, and broached with standard Lapointe machine equipment, this operation being tested by limit plug gages. The large hole in the plain rod has one extra operation to complete the manufacture, namely lapping the crankpin bearing hole to remove about 0.0002 inch of stock. A cast-iron expanding lap and a special lapping compound are used for this operation.

Fig. 20. Final Inspection of Forked Rods

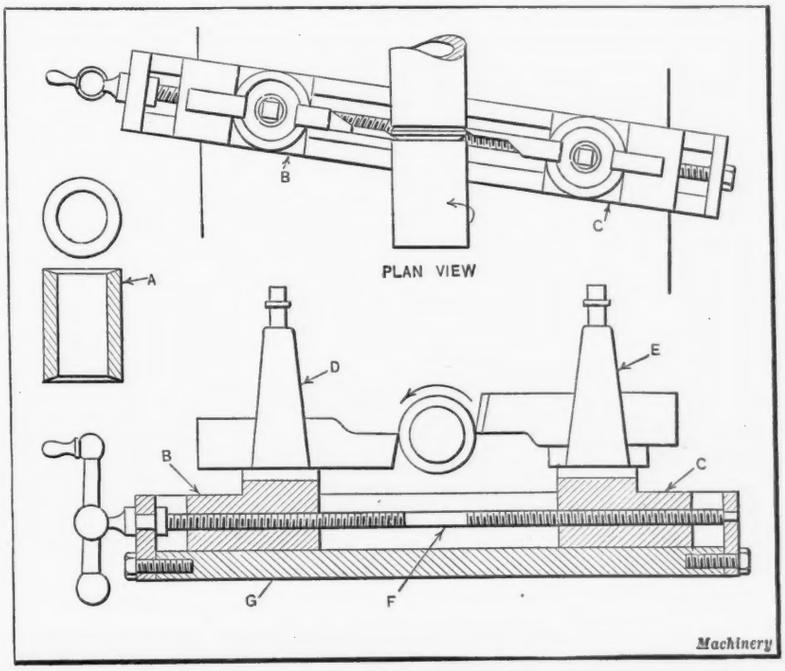
C. H. Wills & Co., manufacturers of the Wills Sainte Claire car, maintain a final inspection department in the Taft-Peirce plant. One corner of this department is illustrated in Fig. 20, where a forked rod is shown being tested for parallelism of the piston-pin and crankpin bearings. At the right is shown another gaging fixture used to inspect the relation of the ends of the piston-pin boss with the finished faces of the crankpin boss.

* * *

## CUTTING-OFF TOOL FOR TUBING

By R. H. KASPER

A large number of bushings like the one shown at *A* in the accompanying illustration were to be made from tubing. The ends of the bushings were required to be cut or faced off at an angle as shown. The usual method of cutting off the tubing to length and facing each end of the cut-off piece separately consumed considerable time. A cutting-off tool which would speed up production was therefore designed. The improved tool consists essentially of two slides *B* and *C*, toolposts *D* and *E*, and a feed-screw *F*. The slides *B* and *C* operate in a dovetail groove in base *G*. One slide has a right-hand thread and the other has a left-hand thread, so that when the feed-screw is turned the slides will move toward or away from each other. The tool in post *D* is held in the usual manner, while the tool in post *E* is turned upside down so that the cutting edge is on the under side.




Tool for cutting off Tubing to make Bushings

The base of the tool is clamped on the vees of the lathe at an angle corresponding to the angle required on the ends of the bushings. The tool in post *D* faces the end of the bushing being cut off, and is set slightly ahead of the tool in post *E* so that separation takes place at the back end of the finished bushing; this arrangement prevents a heavy fin from being formed at that end.

# Bearings and Bearing Metals

By CHRISTOPHER H. BIERBAUM, Vice-president and Consulting Engineer, Lumen Bearing Co., Buffalo, N. Y.

BEARINGS may be divided into two classes: Those having two elements—sliding surface bearings; and those having three elements—rolling surface bearings. The first class only (sliding bearings) will be considered in this article. In discussing the design, construction, and lubrication of bearings, the fundamental laws relating to them, as discovered by a number of investigators in the past, should be taken into consideration. In the light of these laws, the ten principles following may be considered as definitely established for the operation of a properly designed, constructed, and lubricated bearing.

1. The bearing surfaces are completely separated by a supporting film of oil.

2. The friction of operation is the fluid friction in the oil film, and adequate thickness of film is essential.

3. During construction, proper clearance or space should be provided for the normal thickness of the oil film.

4. The advance edge of a bearing surface must be rounded off or chamfered in order to permit a supporting film of oil to form.

5. The oil film forms most effectively upon a bearing surface whose advance edge is at right angles to the direction of motion.

6. An increase of speed increases the thickness of film, all other conditions remaining constant and clearance permitting.

7. An increase in the viscosity of the oil increases the thickness of film, other conditions remaining constant and clearance permitting.

8. The larger the unbroken area of oil film, the greater will be the average pressure-supporting capacity per unit area, other conditions remaining constant.

9. Every unnecessary oil-groove or interruption in the continuity of the oil film reduces the supporting capacity of the film.

10. For every bearing condition there is a film thickness corresponding to maximum lubrication efficiency.

**The author of this article has devoted many years to the study of bearings and bearing metals, and the results of his investigations have been presented from time to time in the technical press and in reports before the American Society of Mechanical Engineers. In the present article, a summary of the practical conclusions that the author has drawn from his experience is given. An original analysis of the action of a journal in a bearing, and information on the hardening and grinding of journals are also presented, and are here published for the first time. This material will form one chapter in a forthcoming handbook to be published by the Lumen Bearing Co. on the subject of bearings and bearing metals.**

### The Action of a Journal in a Bearing

Let us assume that we have a journal 3 inches in diameter, with a clearance of 0.004 inch. The center of the journal will then be able to describe a circle 0.004 inch in diameter, and will also be able to assume any position within the circle. Now, let the diameter of the outer circle of Fig. 1 be equal to 0.004 inch; it will then be possible to plot all the movements of the center of the journal within the circle. After lubrication, set the journal in motion in the direction of the curved arrow, without having any load on it (not even its own weight); the center of the journal will then assume a position in the center of the circle with an oil film of even thickness throughout. Now, maintaining the rotation of the journal and gradually applying a load in the direction of the vertical arrow, it will be found that the center point of the journal will move along a line making an angle of 72 degrees with the vertical, as the load gradually increases. This may be called the load line, which is followed a distance equal to one fourth the amount of clearance, or, in this case, 0.001 inch. Here the oil film is ruptured and the maximum carrying capacity of the bearing will have been reached.

When a bearing is at rest, the loaded journal will be in metallic contact with the bearing at the lower point of its vertical diameter. As rotation begins, rolling of the journal upon the bearing occurs and continues to a point called the angle of repose, where slipping commences and the oil film begins to form. From here it follows the curved line and then assumes a position upon the load line corresponding to the amount of load that it carries.

### Arcs of Maximum and Minimum Pressure

The location of the arcs where the maximum and minimum pressure on the oil film occur is of commanding interest. In the foregoing illustration, as the load is being gradually applied, a maximum pressure begins to develop at a point 10 degrees from the foot of the vertical diameter (measuring all degrees in a counter-clockwise direction), and as the load is increased this point gradually shifts to 45 degrees, while the intensity of the pressure increases from zero to the point of rupture of the oil film. In the same manner, a minimum pressure begins to develop at 184 degrees, and as the load is increased it gradually shifts to 125 degrees as the minimum at rupture, and its value changes from atmospheric pressure to a distinct suction.

The law governing the proper thickness of oil film has not yet been investigated to the extent that the importance of the subject demands. In modern machinery the average thickness of film varies from 0.0002 to 0.006 inch.

### An Example of Proper Supply of Oil

Specific examples will best illustrate the application of the known laws of lubrication. Fig. 2 shows what may be considered ideal conditions, indicating a practical and efficient method of lubricating a crankpin bearing where the journal receives oil through the crankpin. The rotation of the crankshaft is indicated by the upper arrow, and in the position shown the engine is on a dead center, at a point of reversal of pressure. The direction of relative motion of the rubbing surfaces is shown by the two arrows at the right of the figure. The oil film enveloping the right half of the crankpin has been completely restored during the stroke just finished, since the oil-groove passed over this half of the bearing while no pressure was being exerted on it. After the dead center has been passed, the entire pressure is exerted on the crankpin with its fully restored oil film, and at the same time the oil-groove wipes over the other half of the bearing and restores its oil film while no pressure is being exerted on it, after which it, in turn, is ready to receive a reversal of pressure on a fully restored oil film. Thus both halves of this bearing present alternately, for the maximum pressure of each stroke, a com-

plete and uninterrupted surface for maintaining the film on an area equal to the projected area of the crankpin; but it is impossible to obtain so perfect a condition of lubrication in a bearing having the old-fashioned cross oil-grooves, which are still too often found.

In case the direction of rotation of the engine is to be reversed, the oil-groove in Fig. 2 should be placed diametrically opposite its present position. The function of the oil-grooves is to supply oil; in many cases they are necessary evils which should be minimized as much as possible by avoiding a useless excess of grooves, especially in the arcs of maximum pressure as shown in Fig. 1. Unless good and sufficient reason exists to the contrary, oil-grooves should be cut parallel with the journal.

### Objections to Excessively Tight Bushings

The method by which bearing bushings are driven in is of great importance. Either because of neglect, or because the subject is not properly understood, bushings are sometimes driven in too tightly. All bearing alloys have a temperature coefficient of expansion higher than that of cast iron. The bearing bushing is also directly subjected to the friction of the journal, and hence its temperature is higher than that of the cast-iron housing surrounding it. For this reason, all bearing bushings must be allowed an opportunity for an appreciable outward expansion when in operation, and they should be driven in place with just enough pressure on the outside of the bushing to prevent it from coming loose while in operation.

The practice of driving in bushings so tightly that they must be reamed before they can be put into service is very objectionable. Subsequent reaming does not remedy the evil, because a bushing driven in so tightly will continue to contract inwardly when it expands in operation, since the pressure on the outside prevents it from expanding in that direction. If a bushing is driven in too tightly, the amount of clearance between the bearing and the journal becomes a matter of guesswork, and the oil film space provided is uncertain. This is true even though the bushing has been reamed before being placed in service, and is a frequent cause of heating and bearing troubles. Any provision made for fastening the bushing in place should be such that it will not bind or clamp the bushing against outward expansion. If a set-screw is used, for example, it should be provided with a turned down cylindrical end, engaging a hole in the bushing, but it should not bind or bottom in the hole.

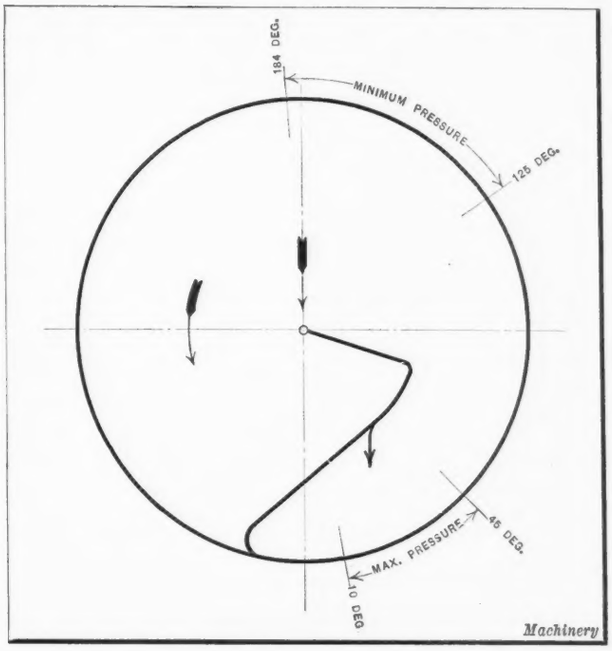



Fig. 1. Diagram showing Action of a Journal in a Bearing

### Designing Bearings for Strength

Fig. 3 shows a bearing used in an established design of a well-known machine which gave trouble from the very first. It is provided with a split bronze bushing, 12 inches long, supporting a journal 6 inches in diameter. The maximum thickness of the bushing is ⅜ inch and it is recessed on its back to a depth of ⅛ inch as shown, leaving a thickness for the larger part of the bearing of only ¼ inch. The cap of the bearing is held down by ten ⅝-inch studs. It is obvious that by clamping this bearing, the bearing surfaces are materially distorted by the pressure resulting from the tightening of the ten nuts. It is also apparent that the thickness of the recessed and unsupported part of the shell is not sufficient to withstand distortion under a normal oil film pressure. The trouble was, therefore, due entirely to the fact that the design is too light, since an examination of this bearing, after a short service, showed that the journal had scored along four circumferential lines corresponding to the four supporting edges beneath the bearing.

### Design of Ring-oiler Bearings

Mention should be made here of another class of bearings which, together with their supports, are often improperly designed, namely, self-oiling ring bushings. These are nearly cut in half at mid-length in order to provide space in which the ring may operate, and the supporting wall beneath the bushing is slotted correspondingly at or near the center to permit the insertion of the ring into the oil-well. This often weakens the bearing unduly at a point where the greatest film pressure is normally exerted. In general, much of the trouble at present encountered in bearings can be overcome by simply increasing the strength and rigidity of the bearings and their supports, since a very small amount of distortion and deflection is sufficient to result in serious bearing troubles.

### Machining Bearings

The manner in which bushings are clamped during machining is of great importance. They should not be clamped by a screw bearing on the outside cylindrical surface of the bushing. This is likely to distort it. Bushings to be machined should be clamped endwise. The importance of this is often underestimated, but it is only by holding the bushing by endwise clamping that distortion can be avoided. If bushings are clamped by screws bearing down on their cylindrical surface, it will often be found that after the bushings have been bored and the pressure released, they are far from round, and if they are then driven on an arbor and finished on the outside, the resulting product is very unsatisfactory.

### Chamfering the Edges of Oil-grooves

The edges of oil-grooves should be rounded off or chamfered, and this work should be done last, after all the other machining work on the bearing has been completed. Any machining after the oil-groove edges have been chamfered is likely to produce a very sharp edge on the oil-groove, which would prevent the formation of an adequate oil film and should be avoided. By rounding or chamfering off the edge the very last thing, this difficulty is overcome.

### Importance of Having Sharp Tools for Machining Operations

It is very important that bearing surfaces be machined with sharp tools having rake. This is true, not only of lathe tools, but also of reamers or other cutting tools used for finishing bearings. It is evident that a tool without rake produces a normal or radial pressure on the bushing far in excess of the pressure produced by a tool having adequate rake; also a dull tool exerts much greater pressure than a sharp tool. In the case of a reamer having, say, fourteen cutting edges, the amount of bursting or internal pressure exerted within a bushing will be very great if the

edges are dull and without rake. The practice of using improper tools for this work cannot be criticized too severely.

The best practice for the final finishing of bearings is to use reamers or cutter-heads having only one or at best a very few cutting edges with a proper amount of rake, such as would be given to a proper cutting tool in a lathe. As pointed out by the author in a paper read before the American Society of Mechanical Engineers, experiments made in a large manufacturing plant on bushings of the same dimensions, produced from the same lot of material, finished at the same time—some, however, being reamed with the standard multiple cutting-edge reamer and others with a single cutting blade—showed that after being stored six months those bushings that had been reamed with a proper single cutting edge retained their accuracy and shape much better than those finished with the so-called "standard" reamer. The latter bushings exhibited a decided tendency to decrease in inside diameter and to assume elliptical forms. It was also brought out at this time that not only a superior product resulted from the use of a proper tool, but that by its use the production could be increased from 15 to 20 per cent.

An additional reason that bearing surfaces should be machined with sharp tools having the proper amount of rake is brought out by a microscopic study of bearing surfaces. In order to obtain the full bearing value of bearing alloys, it is necessary that these alloys be presented as bearing surfaces having their natural crystallization undisturbed. The mutilation, by improper machining, of the bearing surfaces gives rise to the crushing of the harder crystals and then imbedding these crushed particles into a compressed material, which does not permit the natural functioning of a bearing alloy.

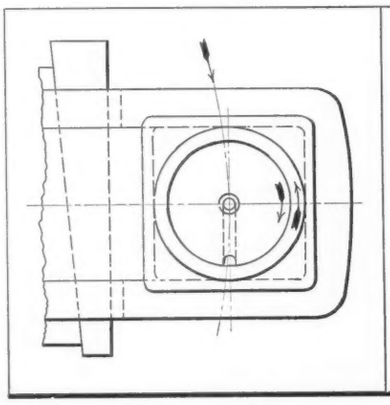


Fig. 2. An Example of Proper Conditions for Lubrication

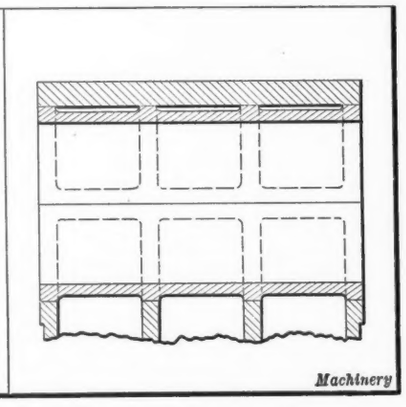



Fig. 3. Bearing with too Thin and Weak a Bushing

### Characteristics of Bearing Alloys

It is well known that a single homogeneous metal is not suited for bearing purposes, but that the first requirement for a bearing metal is an alloy composed of at least two metals, or a metal and a metalloid which should have at least a limited degree of solubility while in the molten state; but upon cooling the alloys should partially separate into dissimilar crystals, and thus form the proper microstructure which is necessary in all bearing alloys.

The need of having a proper microstructure in a bearing alloy is always of far greater importance than its exact aggregate chemical composition. The value of an exact or definite chemical composition is secondary in that it can only serve in producing the desired microstructure in a given alloy, provided the alloy is subjected to the proper cooling conditions.

The essential characteristic of all bearing alloys is a structure made up of alternately hard and relatively soft microscopic particles intimately mixed. The function of the hard particles or bearing crystals is to support the load and resist wear; these bearing crystals should not be hard enough to prove distinctly abrasive to the journal surface. General experience shows that an extreme hardness of the bearing crystals is characterized by excessive wear of the journal. The function of the softer crystals is that of being plastic and of permitting the bearing crystals to adjust themselves to the surface requirements of the journal. These softer crystals are also more readily abraded and, therefore, wear slightly below the surface of the bearing crystals and thus form slight depressions on the bearing surface which serve to retain the lubricant. However infinitesimal in amount this may seem, nevertheless it is this lubricant that prevents scoring or seizing when the journal is starting up from rest at a time when actual metallic contact between the bearing surfaces exists. The same is equally true under an excessive load. This function of retaining a slight quantity of the lubricant on the bearing surfaces when metallic contact exists, characterizes a bearing alloy in its truest sense. Therefore, a bearing metal may be defined as an alloy that is capable of retaining a lubricant on a bearing surface.

In the operation of a bearing under normal conditions, when a continuous and unbroken film of lubricant exists, it matters little what metals are used while the film is sustaining the entire load. In the starting and stopping of the journal, however, or at all times when the film is interrupted and metallic contact exists, it becomes very important that the properties of a bearing metal should be present.

### Hardening of Journals

Steel journals which have been hardened for bearing purposes should have hardened surfaces of an appreciable depth—a depth which is sufficient to permit grinding or polishing of these surfaces without actually cutting through the hardened portion. It is self evident that a surface of insufficient thickness will present a bearing surface of uneven hardness after polishing or grinding. Unsatisfactory results invariably follow in such cases. The hardening of journal surfaces should be done by the pack-hardening process, and enough time should be allowed in the heating to produce a hardened layer of sufficient thickness. The old-fashioned cyaniding process should never be used, because such surfaces, after polishing or grinding, are of very uneven hardness, and general experience shows that this process leads to a great deal of bearing trouble. In cases where a general heat-treating process is resorted to, and where a uniform hardness is produced throughout, the foregoing objections, of course, do not obtain.

### Grinding of Journals

Due precautions should be exercised when bearing surfaces are being ground, to prevent any of the abrasive from being left embedded in the surfaces. This, in general, applies to all bearing materials, but is more particularly of importance in leaded bronzes. For the grinding of bronze bearing surfaces, silicon carbide wheels should not be used, owing to the cleavage of this material, which forms long spicules that tend to embed themselves in the ground surfaces. For this class of grinding the author has found fused aluminum oxide wheels, including natural emery wheels, to give the least difficulty. It is very important to see that all ground bearing surfaces are free from abrasive material before they are put into service.

* * *

The production of automobiles and trucks in October reached a total of 244,000, according to the National Automobile Chamber of Commerce.

## The Manufacture of Full Disk Canvas Wheels, Compressed Muslin Wheels, Leather Wheels, Leather-covered Wood Wheels, and Walrus Hide Wheels—Second Article in a Series

By BRADFORD H. DIVINE, President, Divine Bros. Co., Utica, N. Y.,
and President of the Metal Finishers' Equipment Association

THE solid canvas polishing wheel is made from one-piece or full disks of canvas known as "Dryer canvas." This is a thick heavy canvas with very coarse yarns, and is better suited to a disk form of polishing wheel than a finer, thinner canvas would be. The wheel is constructed by assembling these canvas disks into a wheel, either by gluing each disk to the nearest one to it until the entire thickness is glued together, or by sewing together a number of the disks into sections, something like buffing wheels, and then gluing these sections together. It is evident, of course, that the less glue there is in a wheel the softer it will be, and the different degrees of softness are obtained by varying the number of canvas disks put into each section before the sections are glued together. The softest possible form of canvas wheel is obtained by using no glue whatever, and sewing the layers of canvas together in several rows with heavy twine; for very hard work, such as is met with in the agricultural trade, the sewing is done with copper wire.

To stiffen the center of these wheels so that they will stand up on heavy work, it is customary to use iron or steel plates on each side, the diameter of the plates being usually about four inches less than the diameter of the wheel, leaving two inches of canvas projecting beyond the plates, free and loose to crush out and provide flexibility. When the disks are put together without sewing, that is entirely glued together, an eighteen-inch wheel, for example, is glued for a diameter of eight or ten inches at the center. The construction can, of course, be varied to meet individual requirements, the whole construction depending upon the form of wheel desired for any particular class of work.

Another form of canvas wheel is made from what is known as two-, three-, four-, or five-ply canvas belting. The canvas is woven to about ½ inch in thickness by a process quite different from that by which the Dryer canvas is made. Wheels made of this canvas belting are much softer and more pliable than Dryer canvas wheels, but are used to a much less extent now than formerly, because a much more efficient polishing wheel can be made in the "compress" construction the manufacture of which will be described in a following article. This construction gives the softness desired in a much better form of wheel.

The compressed muslin wheel, which was formerly commonly referred to as a "rag wheel," is made by gluing together sections of pieced-sewed buffing wheels. The sections of buffing wheels are assembled into polishing wheels by practically the same methods as are used in the manufacture of the Dryer canvas polishing wheels.

### Leather Wheels

Leather wheels are usually made from bullneck leather in disk form; a special quality is known as "split leather wheels," and these wheels are made from leather from which both the grain side and the flesh side have been split off, leaving the leather about ⅛ inch thick; this part is the toughest, hardest, and most uniform in grain that can be secured from a cattle hide.

The first step in manufacturing a good bullneck leather wheel is to select a hide of the proper character—one that is not filled with clay or glucose, but is left pure and porous so that it will be resilient. The hide must also be thoroughly tanned by the old-fashioned process which takes months, instead of by some of the newer processes in which the tanning is rushed; these processes do not leave the fiber of the hide in as good condition for polishing as the old-time process. The shoulder of the bull produces a hide much coarser and more sponge-like than is the same hide back of the bull's shoulder to his tail. The bull shoulder hides vary in thickness from ¼ inch at the flank or leg to ¾ inch, or sometimes 1 inch, at the heaviest part in the back of the neck behind the horns. In cutting the disks for bullneck wheels, the purpose for which the wheel is to be used determines what part of the hide these disks shall be cut from, in order to secure a disk as equal in porosity and density as possible.

After the disks are cut, the loose portion on the flesh side or inside is removed, and often a considerable part of the hair- or grain-side has to be removed also, on account of the deep wrinkles in the hides. These disks are then held together by glue to which has been added isinglass or some other adhesive having a toughness and strength many times greater than that of the best glue. Wheels put together with glue not mixed with isinglass will frequently split apart. Great care must be taken to see that the glue, or cement as it becomes when mixed with isinglass, is properly applied to the leather disks. Upon the application of the glue to the disk it must be immediately placed in relation to the next disk, the whole mass being kept hot; and when

the entire mass of disks for each wheel is assembled it must go into a press immediately, so that the glue will set uniformly throughout the entire wheel while under pressure. After the wheel is thoroughly dry, the center hole is bored. It is then placed on an arbor and the sides and face are trued up to the right dimensions. Bullneck wheels are commonly sold by weight, rather than by wheel units. The variation in weight of the hides, which is not controllable, prevents the manufacturer from putting out a fairly balanced wheel, and the balancing has to be done by the operator after he has set up the wheel with emery and glue.

The bullneck wheel is not adapted to finishing work on account of the alternating layers of leather and glue in the wheel. The glue is stiffer than the leather and will resist the pressure, while the leather will crush down with the result that the face of the wheel wears in ridges or grooves and cannot be kept flat. Such wheels are generally used on rough forms of work where a flat face is not essential.

Wheels made of split leather retain their shape better than regular bullneck leather wheels and are advantageous for certain classes of work. The method of construction is practically identical to that used for the bullneck wheel, the difference being only in the thickness and character of the stock used.

### Leather-covered Wood Wheels

Although leather-covered wood wheels are not generally regarded as efficient polishing means, they are extensively used where the advantages of other wheels are unknown, there being a reluctancy on the part of some polishers to give up the old form of leather-covered wood wheel to which they are accustomed. The polisher knows that the leather strip on the face of the wheel often becomes loose, especially where the old heads of emery and glue are removed by a wet process. He also knows that the joining of the ends of the leather strap makes a spot which is harder than the rest of the face of the wheel; on accurate work, the shock of this hard spot can be plainly felt in the operation of the wheel, and on this account a smooth steady cut is difficult to secure.

The wood body of the wheel, especially when made of a soft wood, is susceptible to change in shape on account of dryness or moisture, and a wood wheel which runs true is a rarity and is highly prized by its owner. But inasmuch as wood wheels were one of the original forms of polishing wheels, and many old-time polishers have used them for years, there seems to be a strong conservative force that is responsible for their continued use.

The best wood from which wood wheels could be manufactured is mahogany, black walnut or other woods that are not very susceptible to the action of moisture and dryness. The cost of such woods, however, is prohibitive. Good white pine is the best common wood obtainable for polishing wheels. Bass wood and poplar are commonly used in a cheaper form of wheel, mainly because the wood is free from knots, comes in wide planks, and is easy to cut wheels from without much waste.

Fig. 1. Assembling Disks of Cloth for Solid Canvas Polishing Wheels

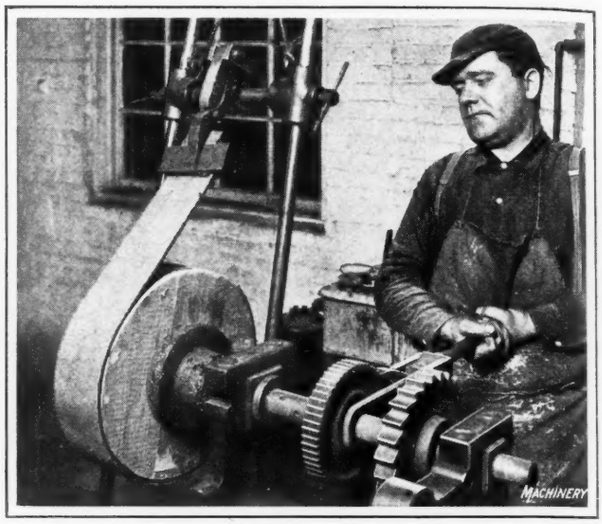



Fig. 2. Attaching the Leather to a Leather-covered Wood Polishing Wheel

In the standard pine wheel, the wood is air-dried and kiln-dried and usually cut ½ inch thick. The boards are cut in square blocks of the proper thickness for the wheel, the layers or strips being at right angles to each other and held together by means of nails (afterward removed) so that they cannot slip out of position while they are being dried in a press after the glue has been applied. After the square blocks are glued together, the center hole for the hub and the countersink for the flange of the hub are bored with a compound tool. The square block is sawed to an approximately round shape and then the wheel is turned to shape in a lathe, after the hub has been inserted.

The leather used for the covering of wood wheels is usually a strip down the back of the animal which is the closest grained, toughest and most uniform part of the hide. This is the most expensive kind of leather and gives the widest strips and the longest lengths of uniform density obtainable. The face of the wood is first sized as a bedding for the glue. The strap is placed in position as shown in Fig. 2, and stretched as it is wound around the wood center, both the leather and the wheel having been previously coated with hot glue. The ends of the straps are allowed to overlap and the butt joint made a close fit by cutting through both layers at the same time with a very thin sharp knife. The ends of the leather at the joint are held in place by wooden shoe pegs; in special cases iron pegs are used, which are removed after the glue is thoroughly set. In addition to holding the leather strap on the wood block with glue, wooden shoe pegs spaced in rows across the face of the wheel are used. Some straps are put on without pegs for the finer finishing processes. After the leather strap is thoroughly set, the wheel is placed in a lathe and the face turned off, leaving the greatest depth of leather possible. The strap is then sanded and finished, the wood part of the wheel well shellacked and varnished, and the wheel is ready for use when dry.

On large diameter thin wheels, 18 to 24 inches in diameter by 1 inch to 1½ inches face, side flanges of wood are used, these being glued to the body of the wheel to increase the thickness of the wheel at the hub and the resistance to side-warping. Sometimes an additional flange is used on the other end of the hub, but this is seldom necessary, and its use is a matter of custom rather than need.

### Walrus Hide Wheels

Walrus hide is, as the name indicates, the hide of the walrus. Its soft, coarse, porous character permits it to be worked into a very soft cushion on the face of the polishing wheel. The hide comes in thicknesses of from ½ inch to 2 inches (occasionally 2½ inches), which permits a wheel to be cut out of one piece without gluing together disks, as is necessary in other forms of wheels. The great expense of walrus wheels has led the user of polishing wheels to seek other forms; the most common substitute for wheels 10 inches in diameter and larger, has been the compress canvas wheel, the control of the density of which permits a cushion to be secured that will do exactly the same class of work as the solid walrus wheel, with rare exceptions; but walrus wheels are still employed in the silverware trade, for "sand buffing," where polishing wheels of from 2 to 10 inches in diameter are most commonly used. There are many classes of work on which it would not be permissible to use any kind of wheel with glue or other adhesives in it, and the walrus wheel being of the proper texture, and thick enough to produce wheels up to 2 inches width of face, lends itself to that class of work. The manufacture of walrus wheels consists only in cutting out the circles, cutting the center hole, and truing up the sides and face.

Sheepskin polishing wheels have almost entirely disappeared, due to the substitution of other forms of wheels. They are, however, made up of russet or white sheepskin in the same manner as Dryer canvas disk wheels—that is either by gluing the full disks together at the center, or sewing them with one row around the center, or with several rows of hand sewing; or by cementing them together into a solid wheel. They are, of course, centered and trimmed in a lathe like all other wheels.

Paper wheels have almost gone out of existence, but they were formerly manufactured by gluing together disks of strawboard or soft felt paper, such as a carpet paper, cutting the center hole and truing up the face. In some cases cast-iron hubs were inserted as a special feature.

In the description of a line of manufacture of this kind, it is possible to include only the more standard forms of wheels made, as there are many varieties of wheels of special shapes for various purposes. The next article in this series will deal with the actual manufacture of compress polishing wheels.

* * *

## IMPROVING INSPECTION METHODS

By H. H. ARMSTRONG

Inspection plays a particularly important part in plants where large quantities of cast-iron parts are machined on automatics. An automatic machine may operate continuously all day, with very little attention without spoiling a single piece of work; then again it may require constant attention and frequent adjustment in order to keep the work up to specifications. In any case, the finished work must be inspected with gages or micrometers, and all parts rejected that fail to meet requirements.

### Inspecting the Work as it Comes from the Machine

If the work is inspected as soon as it comes from the machine, the inspector will detect any errors at once and have the set-up corrected before many pieces are spoiled. If he cannot do this and the operator does not check the pieces at all and is running, say, four machines, the pieces awaiting inspection quickly pile up in large quantities. This is obviously not a good practice, and too often results in the necessity for scrapping a large number of pieces. In such cases the inspector must sort out the spoiled pieces that cannot be used. While this prevents defective parts from reaching the assembly department, it does not prevent parts from being spoiled. A method that will bring the loss in scrapped parts down to a minimum is obviously desirable. The writer believes that in the majority of cases the desired results will be obtained by having the inspector act as a "machine checker." In other words, the inspector goes from one machine to another, continually testing the product as it comes from each machine. If he finds the work within limits, it is passed on to the next operation or to the assembly department, as the case may be. If the checker finds a machine that is producing work that is not up to requirements, it is a small matter to stop the machine and have the set-up corrected. He must then check the pieces that have been made and work back to the point where the spoiled parts first appeared. The spoiled pieces may then be segregated and thrown out.

When the operator sets up his machine for a job, it is good practice to have the inspector or checker carefully check the first piece produced. If the piece checks up with the drawing specifications, the machine may be put in operation and afterward checked periodically. Foremen in their efforts to meet the factory schedule do not like to have their work held up; consequently the machine checker is sometimes criticized or blamed by the foreman for holding up work that in his opinion will pass inspection. The inspector, however, should be amply backed up by the management for stopping work that he believes should not pass inspection. If the operator of an automatic has been started correctly on a piece of work and provided with gages so that he can inspect the work himself, there should be no excuse for spoiled parts. If a lot of work is done wrong, the checker may in some cases insist that the pieces be fixed up or salvaged by the operator on his own time. This will be a lesson for the operator that should make him more careful.

### Inspection Procedure in Press Room Work

This procedure is equally applicable to press room work. Generally a man known as the die-setter sets up all work in the press room, and when he has produced a piece which in his estimation is right he passes it on to the checker. The checker carefully inspects the piece, and if it is found correct he instructs the operator to go ahead. If the operator is careful he will keep close watch of the work and if he notices any change in the product he will immediately take the piece to the checker for advice. There are so many things that may happen to a die while it is in operation that it is imperative for the inspector to keep constantly in touch with each machine.

What is true of the automatic machine department and the press room is equally true of nearly all departments. A careful study of the inspection methods and a checking up of the amount of work spoiled in various machining operations will serve to emphasize the importance of "machine checking" (checking the product as it comes from the machine) and show more clearly the impracticability of depending on a final inspection to eliminate defective parts.

* * *

EXPORTS OF MACHINE TOOLS AND METAL-WORKING MACHINERY TO DUTCH EAST INDIES, 1912-1921

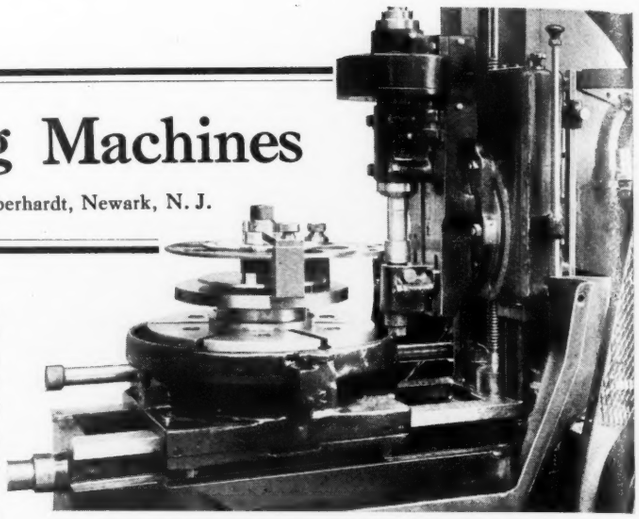
| Year* | Lathes | Sharpening and Grinding Machines | Other Machine Tools | Total of Machine Tools | All Other Metal-working Machinery | Total of Machine Tools and Metal working Machinery |
|---|---|---|---|---|---|---|
| 1912 | ..... | ..... | ..... | ..... | ..... | $26,443 |
| 1913 | ..... | ..... | ..... | ..... | ..... | 6,366 |
| 1914 | ..... | ..... | ..... | ..... | ..... | 20,216 |
| 1915 | ..... | ..... | ..... | ..... | ..... | 9,229 |
| 1916 | ..... | ..... | ..... | ..... | ..... | 56,281 |
| 1917 | ..... | ..... | ..... | ..... | ..... | 245 594 |
| 1918 | $53,664 | $8,737 | $38,239 | $100,640 | $68,044 | 168,684 |
| 1919 | 273,302 | 27,412 | 81,144 | 381,858 | 232,640 | 614,498 |
| 1920 | 88,826 | 25,577 | 80,186 | 194,589 | 131,497 | 326,086 |
| 1921 | 76,512 | 17,165 | 104,660 | 198,337 | 163,059 | 361,396 |

*Machinery*

*Amounts given are for fiscal years, up to and including 1918, and for calendar years thereafter. The Department of Commerce statistics did not give machine tools separately previous to 1918.

# Testing Gear-hobbing Machines

By D. VAUGHN WATERS, Mechanical Engineer, Gould & Eberhardt, Newark, N. J.



IN no other class of machine tool is the exact synchronization of relative velocities between different members so essential as in gear-hobbing machines. That this is so will be readily appreciated from a brief consideration of the fundamental principles underlying the production of gears by hobbing. A hob cuts teeth in the periphery of a gear blank by means of the molding-generating process, the principle of which is that of rolling a rack in contact with a plastic blank, whereby involute teeth conjugate to those of the rack are formed in the blank. The normal section of the hob teeth corresponds to the rack teeth. If now, the rack were imagined to have rotating cutting edges capable of imprinting the tooth contour in the periphery of the blank, the results would be identical with those obtained by hobbing.

Since the circumference of the pitch circle is equal to the product of the normal circular pitch of the hob and the number of teeth to be cut, it is obvious that the circumferential velocity of the pitch circle and the velocity in an axial direction of the cutting elements of the hob teeth must be the same. In fact, these velocities must not only be equal for each successive revolution of the hob, but they must be equal at all parts of the revolution as well; otherwise the blank may accelerate or retard an infinitesimal amount during which the hob would generate teeth either thicker or thinner than the theoretical size.

A diagrammatic representation of the gearing connections necessary in a hobbing machine is shown in Fig. 1. The diagram shows only the simplest construction, for in an actual machine additional members may be added for constructional reasons or a differential mechanism incorporated to facilitate cutting helical gears, etc. An inspection of this diagram and consideration of the foregoing principles will make it clear that the hob must rotate in a predetermined ratio with the gear to be cut. It is highly essential, therefore, that the work-spindle and the hob-spindle rotate at a certain relative velocity and that this ratio be maintained as uniform as possible throughout the revolution of the spindles.

In a mechanism such as a gear-hobbing machine composed of gears, bearings, thrust washers, shafts, worms, etc., it is possible and highly probable that the machine as assembled at the shop may have slight errors in one or more of its component parts. Such errors are difficult to detect, and they will cause the machine to produce inferior work if not discovered and rectified. When a hobbing machine produces gears that do not measure up to the high standards established for certain classes of work, such as automotive timing gears, machine tool gearing, etc., either the machine or the hob is faulty. Hobs as manufactured today are closely inspected for truth of all essential dimensions before delivery to the customer, and can usually be relied upon to be as nearly correct as they can be made commercially. Notwithstanding this, methods of inspection should be employed that will definitely indicate whether the hob or the machine is at fault, and that will point out approximately where the defect lies.

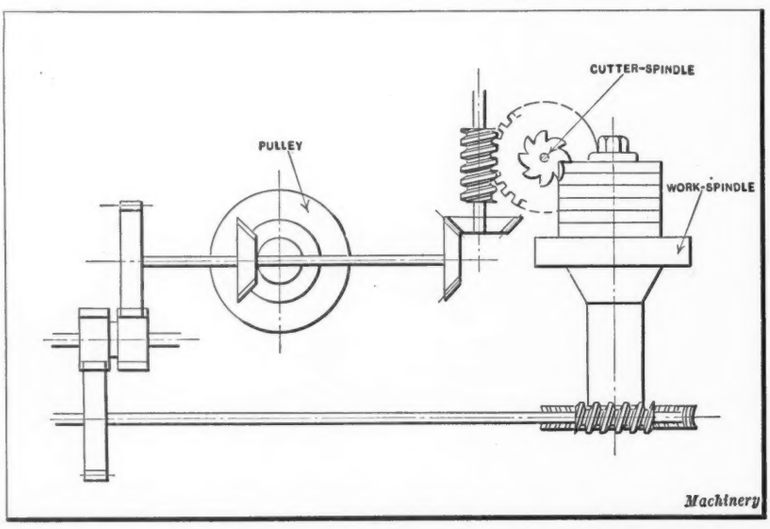



Fig. 1. Diagram of Cutter- and Work-spindle Gearing on Gear-hobbing Machine

### Angular Velocity Testing Fixture for Hobbing Machines

In connection with the inspecting of hobbing machines, the angular velocity testing method used by Gould & Eberhardt, Newark, N. J., to check the uniformity of relative rotation of cutter- and work-spindles on Gould & Eberhardt gear-hobbing machines, is here described. A special testing fixture is applied to the machine, which graphically records the amount of deviation in cutter- and work-spindle speeds from their theoretical angular velocity ratio. This fixture is illustrated in section in Fig. 2, and its application is shown in Fig. 4. For the purpose of conducting the test, the swivel-slide is rotated so that the axis of the cutter-spindle is parallel to the axis of the work-spindle, as shown in Fig. 4.

The design of the fixture is more clearly shown in the sectional view, Fig. 2. It will be seen that the fixture consists of a base *A* secured to the work-spindle of the machine on which the various parts of the fixture are supported. Fixed in this base is an arbor *B* carrying disk *E*, bushing *C* and a retainer nut *D*. Bracket *F*, mounted on disk *E*, controls the movement of the stylus. Obviously all these parts move in coincidence with the work-spindle. Supported by disk *E* there is a large disk *G* which is fitted over bushing *C* and driven through contact with the compound disk *H*, the latter, in turn, being driven from a collar *J* on the cutter-spindle of the machine.

Immediately above the disk *G* there is a smaller disk *K* upon which the paper dial is secured. This disk does not rotate and is prevented from doing so by the following arrangement. There is a large disk *O* carried on the base *A*, which is free to rotate. This disk carries two brackets, one

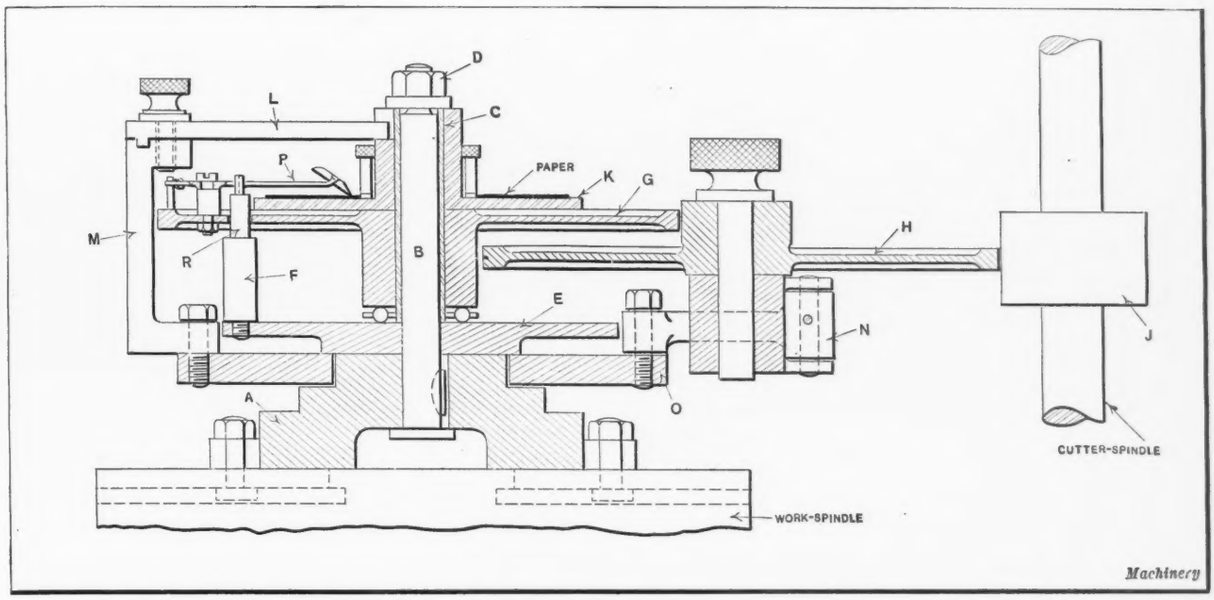



**Fig. 2. Sectional View of Angular Velocity Testing Fixture used in testing Hobbing Machine Work- and Cutter-spindles**

of which, *N*, furnishes the bearing for compound disk *H*, and the other, *M*, carries the stop *L*. This stop prevents disk *K* from rotating when disk *H* is brought to bear against collar *J* (see also Fig. 4), which stops disk *O* and all the parts supported by it from rotating about the work-spindle center. The paper dial is thus held stationary while the members that actuate the movement of the stylus arm *P* rotate.

The fulcrum of the stylus arm is mounted on disk *G*, and this arm is normally held tightly against the stop *R* by a small tension spring. Stop *R* is a part of bracket *F* and, of course, rotates with disk *E* and in unison with the work-spindle. Disk *G*, as previously mentioned, is driven by the compound disk *H*, and its angular velocity is by the same means reduced to nearly that of the work-spindle. A slight difference between the angular velocities of disks *G* and *E* will result in a spiral being traced by the stylus point instead of a circle, which is an advantage because two or three revolutions can then be recorded and the average amount of deviation taken. This slight difference in angular velocities of the two disks is provided by suitable gearing in the machine. The movement of the stylus arm is controlled by its contact with stop *R*. It is obvious, therefore, that any change in angular velocity of either of the two disks will cause a wavering movement of the stylus arm, proportionate to the amount of variation between the work-spindle and the cutter-spindle. This variation is then recorded on the paper dial secured to disk *K*.

Charts showing the results of these tests are reproduced in Fig. 3. The record shown at the left is that of a machine having defective gearing. It should be particularly noted that the inequalities in the spiral traced by the stylus, each about 3/16 inch high on the actual chart, are the graphic record of inaccuracies in the machine which are too small to be measured but which affect the accuracy of the gears.

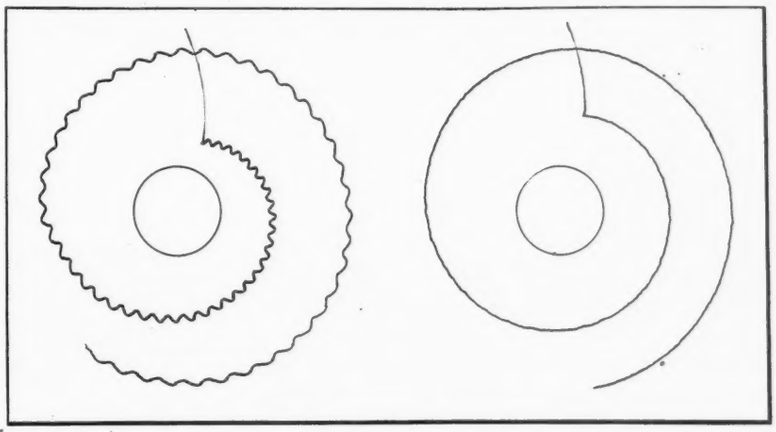


**Fig. 3. Spirals traced on Paper Dial to show Variation in Speed of Cutter- and Work-spindles under Two Conditions**

In some cases, departure from the uniform angular velocity ratio may be caused by tightly meshing change-gears, by dirt which has been allowed to remain between the collars and clamped therein, thus springing the arbor or spindle, or by numerous other factors under the direct control of the machine operator. These causes of variation in velocity are also revealed by the use of this type of fixture. Again, in some machines there may be two shafts or gears that have the same "period," or in other words, that terminate their revolutions at the same instant. This condition tends to accentuate the minute defects that may be present in the angular velocity of each. When this condition is present, the device described will unfailingly delineate the fact and enable corrective steps to be taken.

The spiral shown at the right in Fig. 3 is a graphic record taken from the same machine as that shown at the left, but after the mechanism had been carefully inspected and the inaccuracies remedied. It is obvious from this chart that the machine, as thus corrected, has very nearly a perfect uniformity of angular velocity between the cutter- and work-spindles. In other words, the comparative evenness of the spiral shows that the difference in speed of the two disks that control the movement of the stylus was so slight as to hardly cause any fluctuation at all.

### Another Design of Testing Fixture for Hobbing Machines

A testing fixture recently placed on the market by the Illinois Tool Works is illustrated in Fig. 5. This fixture is also used by Gould & Eberhardt in conjunction with the one previously described. It consists fundamentally of a large disk mounted on a vertical arbor or spindle, which is attached to the hobbing machine work-spindle. Above this large disk there are two arms, one of which rotates in unison with the disk that is driven from the cutter-spindle, and the other in unison with the work-spindle. The arm that operates in

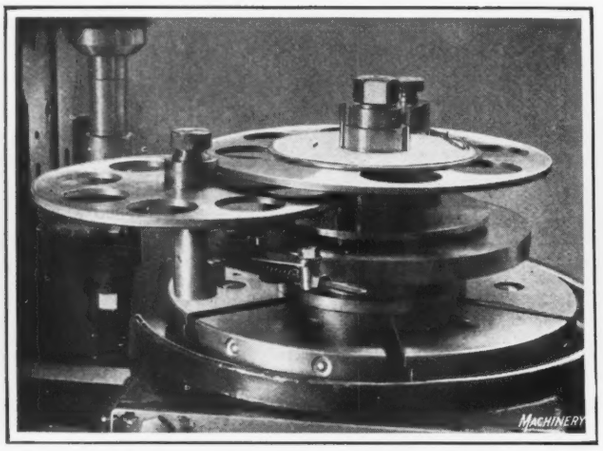


Fig. 4. Application of Testing Fixture to Hobbing Machine

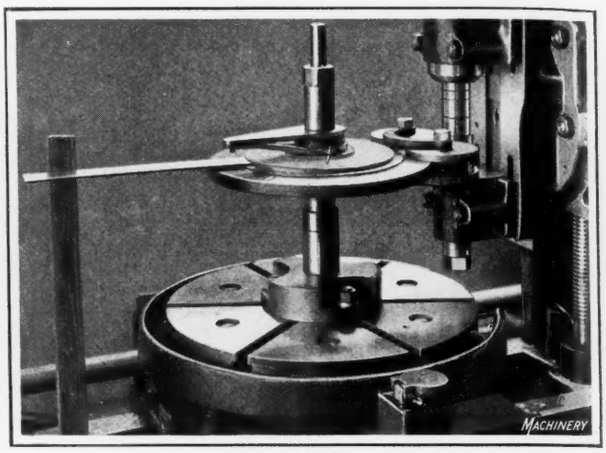


Fig. 5. Fixture of Similar Construction to that shown in Fig. 4

unison with the work-spindle carries a stylus at the end of a lever, and its angular position is influenced by an adjustable lug carried by the arm that rotates in unison with the disk.

The large disk is driven in much the same way as the disk that carries the stylus arm in the design of fixture previously described; it is rotated by means of a series of smaller disks, which are, in turn, driven by a collar on the cutter spindle. These disks and the arm revolve in coincidence with the cutter-spindle, and they control the movement of the stylus arm that revolves with the work-spindle. The stylus traces a graphic record of the variations of angular velocity ratio between the spindles on a paper dial. The disk on which this dial is mounted is prevented from rotating by an arm projecting radially and bearing against some stationary part of the machine. From this brief description it will be seen that this fixture is somewhat simpler than the one illustrated in Fig. 4, although the principle of operation is identical.

* * *

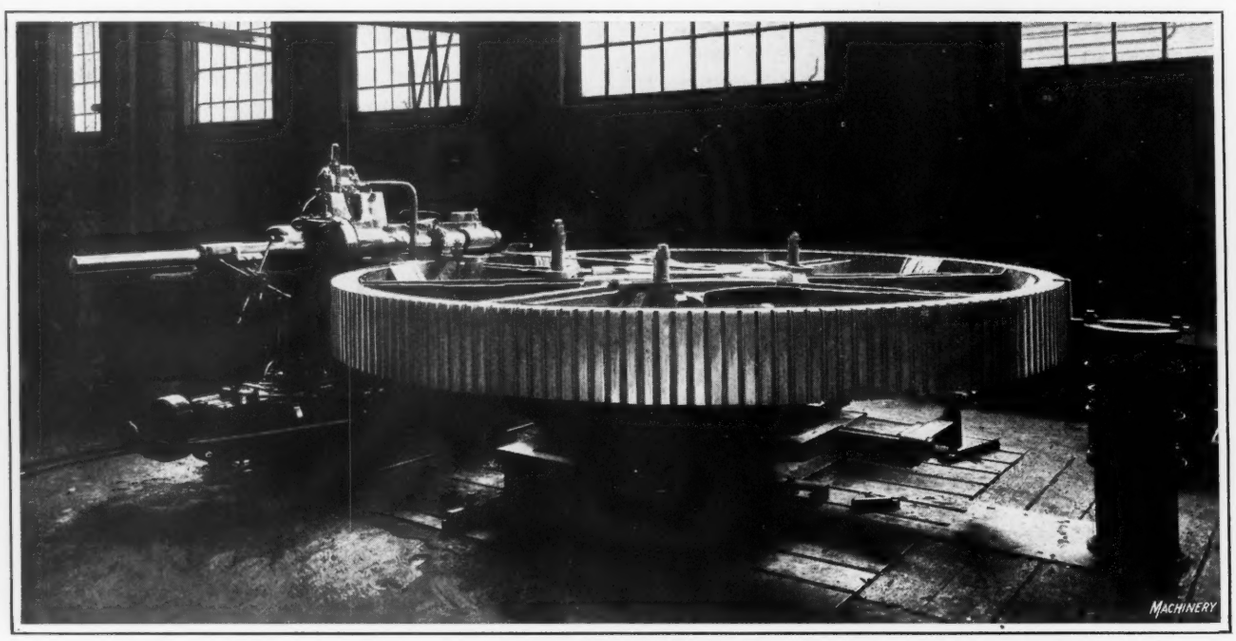
The American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., now has a membership of over 3100 members distributed throughout practically all of the industries. In the iron and steel industry alone, there are 228 members, and in the industries manufacturing products from iron and steel, including machinery, tools, and hardware, 271 members. Non-ferrous metals and alloys are represented by 128 members.

## LARGE GEAR CUT WITH A HORIZONTAL BORING MACHINE

An unusual method of cutting a large cast-steel gear was employed at the Union Plant of the Bethlehem Shipbuilding Corporation, Ltd., San Francisco, Cal., where a Lucas horizontal boring machine was used for this purpose, as shown in the accompanying illustration. This gear, which is the main bull wheel for a dredge, has a pitch diameter of about 14 feet, a face width of 15 inches, and 192 teeth of 2¾ inches circular pitch.

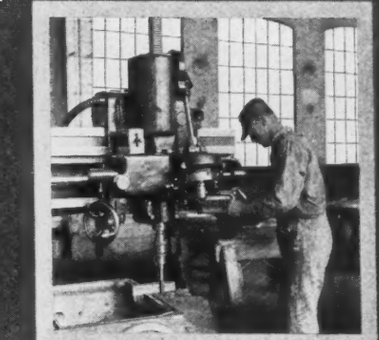
The gear was mounted on a revolving table taken from a large slotter. The lower slide for this table was bolted to a floor plate. A cutter having a diameter of 10 inches was used, and one roughing and one finishing cut was required for each tooth space, the teeth being milled from a solid rim. The cutting speed was 60 feet per minute, and the feed per cutter revolution was 0.027 inch.

In order to regulate the indexing, the tooth spaces were marked on the side of the gear blank and a pointer was attached to the machine. The gear was rotated for indexing by means of the revolving table, the pointer being set in alignment with the different division marks for milling successive teeth. Another fixed pointer was located on the opposite side of the gear to act as a double check. This gear-cutting operation illustrates how horizontal boring, drilling, and milling machines, as well as certain other types of machine tools, can be adapted for special work.



Lucas Horizontal Boring, Drilling and Milling Machine being used for cutting a Large Cast-steel Gear

# Letters on Practical Subjects



## BURNISHING PISTON-RING GROOVES

One manufacturer solved the problem of obtaining smooth, accurately sized ring grooves in a certain type of automobile piston by the use of a burnishing tool. The piston is shown by the heavy dot-and-dash lines in the illustration. It is 3¼ inches in diameter and has three grooves, each of which is required to be held to a width of not less than 0.187 or more than 0.188 inch. The piston is located and driven by an adapter attached to the lathe spindle. The tailstock center also serves to support the piston during the burnishing operation. The work is run at a speed of 45 revolutions per minute, and the entire burnishing operation is performed in fifteen seconds.

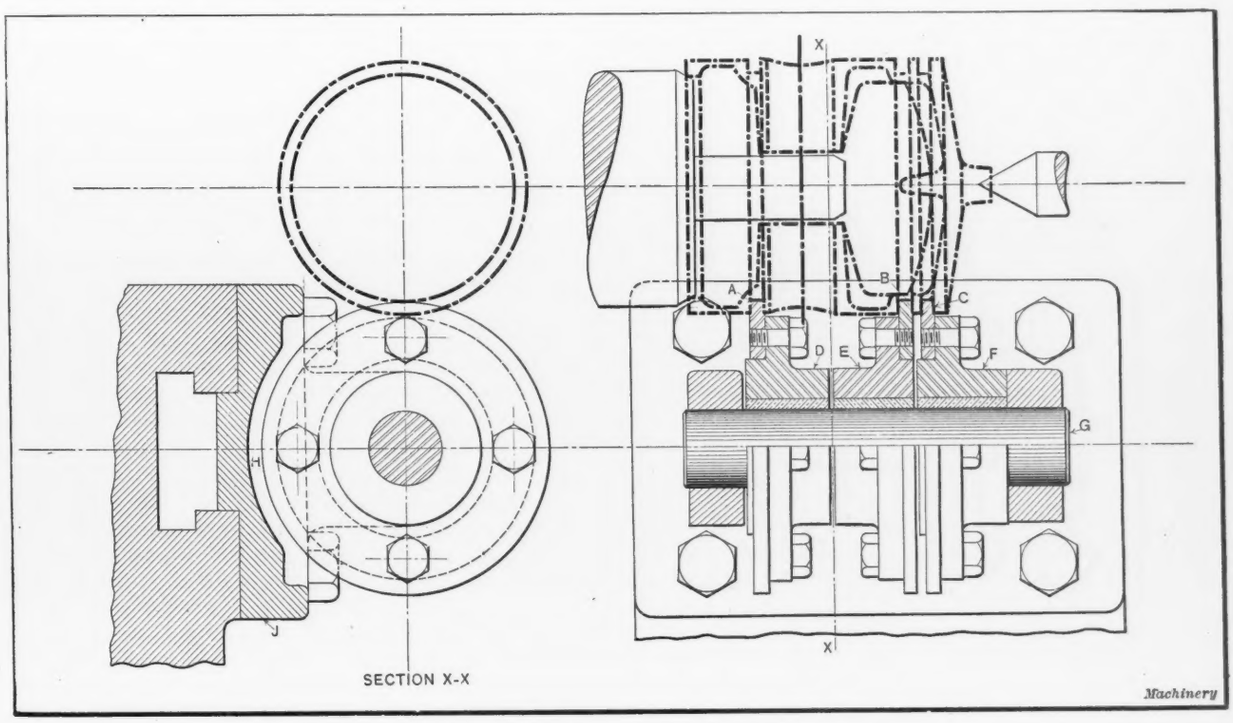
The burnishing tools *A*, *B*, and *C* are in the form of collars or washers made of high-speed steel. These tools are hardened, ground, and lapped to the correct width, and are secured to holders *D*, *E*, and *F*, as shown. The holders are made of machine steel and are fitted with brass bushings which are a good running fit on the hardened and ground tool-steel pin *G*. The holders are permitted to float sidewise to compensate for any variation in the spacing of the grooves.

The block *J* on which the burnishing tools are mounted has a depression at *H* which is kept filled with oil for lubricating the burnishing tools. Block *J* is fitted to the tool-slide of the lathe by means of machine screws and dowels. From 0.0002 to 0.001 inch is left in the ring grooves for burnishing. This allowance is sufficient to give a smooth finish and permit the tool marks to be removed. In operation, the burnishing tools are fed into the piston grooves by hand. After the tools have reached the bottom of the groove, the piston is permitted to make two revolutions before the tools are withdrawn. This type of burnishing tool has proved very satisfactory. Only one set of burnishing tools was required for finishing the grooves in a lot of 20,000 pistons.

Lakewood, Ohio — H. G. FRANTZ

## WASTE OF MATERIAL

Materials are wasted, perhaps, to a greater extent in railroad shops than anywhere else. Removed parts are likely to be scrapped, instead of being reclaimed in one of the following four ways: (1) Repaired by any suitable method—in case of broken parts, for example, by oxy-acetylene or autogenous welding—and used again; (2) put aside by some systematic method for subsequent repair to be used elsewhere; (3) converted at slight cost into similar pieces of other dimensions and used elsewhere; (4) converted economically into other pieces or articles useful in the railroad shop.




**Tools used for burnishing the Ring Grooves in Automobile Pistons**

Judgment, of course, must be used in determining upon the repair or utilization of material that would otherwise be scrapped. If the repairs cost more than new parts, which sometimes happens, especially if the repair work is inefficiently conducted, it is evidently cheaper to scrap the parts.

The collection of a great deal of scrap is often evidence of inefficient management, because it shows that parts have been allowed to become worthless, or comparatively so, through neglect, when they might have been saved if attended to in time.

New York City — ROBERT GRIMSHAW

## PIERCING AND BLANKING DIE

The compound die illustrated in Fig. 1 is designed to pierce and blank the special washer shown in the lower right-hand corner of Fig. 2. This washer is used on the shaft of a generator which comprises part of the electrical equipment of an automobile. The triangular-shaped pieces of cold-rolled steel from which the washers are blanked is 1/16 inch thick. The manner in which the stock is located on the die is illustrated in the upper view of Fig. 2. In this view, *A* represents the die, and *B* and *C* the locating or stop pins. The height of the heads of the stop pins is 0.010 inch less than the stock thickness.

A piece of stock from which the washers have been blanked is indicated by dotted lines at *D*. This illustration shows the manner in which the stop pins *B* and *C* are employed to locate the stock. In piercing and blanking the first washer, the stock is held in such a position that it is in contact with pins *B* and *C* at points *E* and *F*. The order in which the washers are blanked, beginning at the upper right-hand corner, is from left to right, as indicated by the numerals 1 to 10, the positions for the first blanking operation on the second row being indicated at *G* and *H*, and for the succeeding operation at *J* and *K*. This method of locating the stock is continued until the last washer is blanked at *L*.

The operation of the die is similar to that of any ordinary compound die. The piercing punch *C*, Fig. 1, pierces

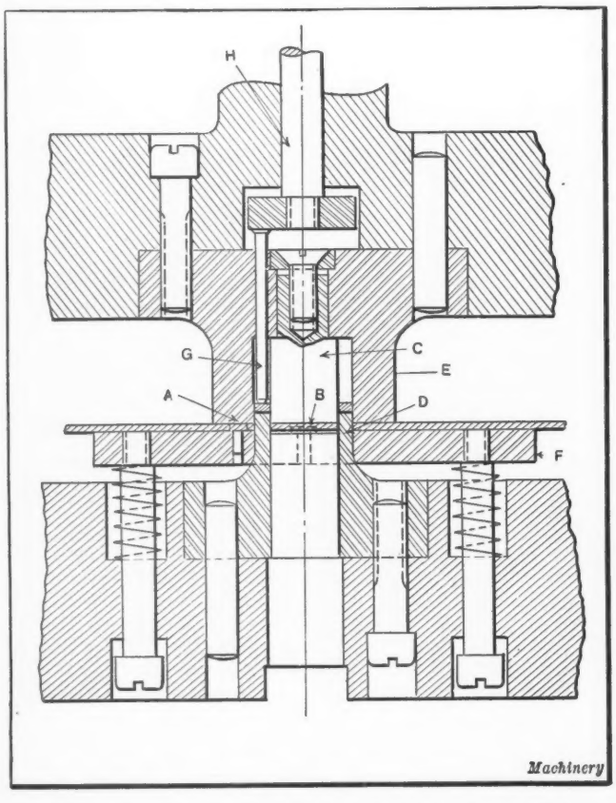



Fig. 1. Compound Die for piercing and blanking Special Washers

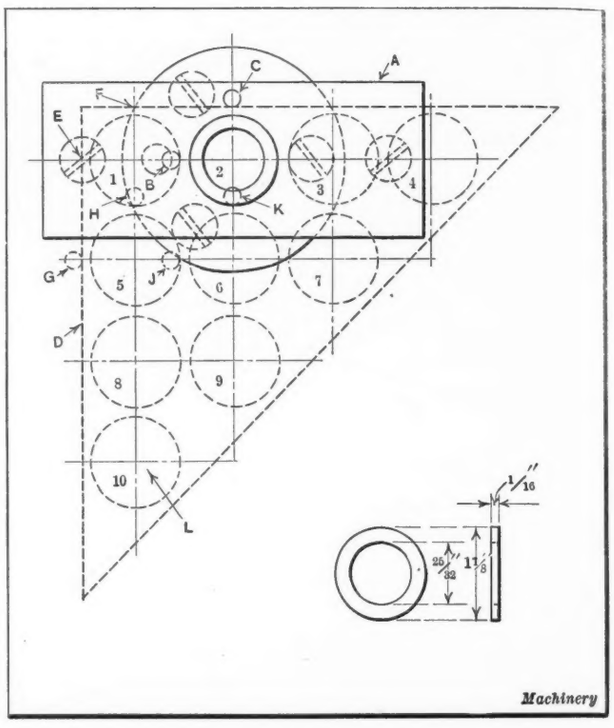



Fig. 2. Diagram showing Method of locating Stock on Die

the 25/32-inch hole, and punch *D* blanks the 1⅛-inch outside diameter. Stripper *F* strips the stock from the punch on the upward stroke, and the three knock-out pins, one of which is shown at *G*, eject the blank from the die *E* through the action of knock-out rod *H*. The punch and die members are kept in alignment by two pillars located at the back of the die-bed. This type of die, when furnished with locating pins as described, provides an effective means of producing special washers when the quantity required does not warrant building a more expensive die of the multiple type, or when small pieces of scrap stock are used.

Brooklyn, N. Y. — JOHN A. HONEGGER

## DRILLING A SMALL DEEP HOLE

The writer recently encountered an interesting drilling problem in making a small bushing for a special machine. The bushing was to be made of cold-rolled steel and was to be 13/16 inch long with a hole 0.0135 inch in diameter drilled its entire length. It was required to be turned down to a diameter of 1/16 inch for a length of 7/16 inch at one end and to a diameter of ⅛ inch for the remaining length. Several fine tool manufacturers and watchmakers were called upon to make this bushing, but they declined to accept the job because of the difficulty that would be experienced in drilling such a small hole through 13/16 inch of metal. The writer was therefore obliged to make the bushing on an ordinary 12-inch lathe, which was the smallest machine available for the work.

The small hole was started with a combination drill and countersink. A No. 80 drill was then put in a pin vise, and the shank of the vise placed in the drill chuck of the tailstock. The drill chuck was adjusted so as to allow the shank of the pin vise enough play to permit the drill to follow the hole already started in the steel. Instead of feeding the drill with the tailstock in the usual way, the vise was held in the hand and very carefully moved forward so that the drill was pressed lightly against the steel. The lathe spindle was, of course, driven at the highest speed available.

After drilling to a depth of about ⅝ inch, the bushing was cut off. A piece of cast iron was then placed in the

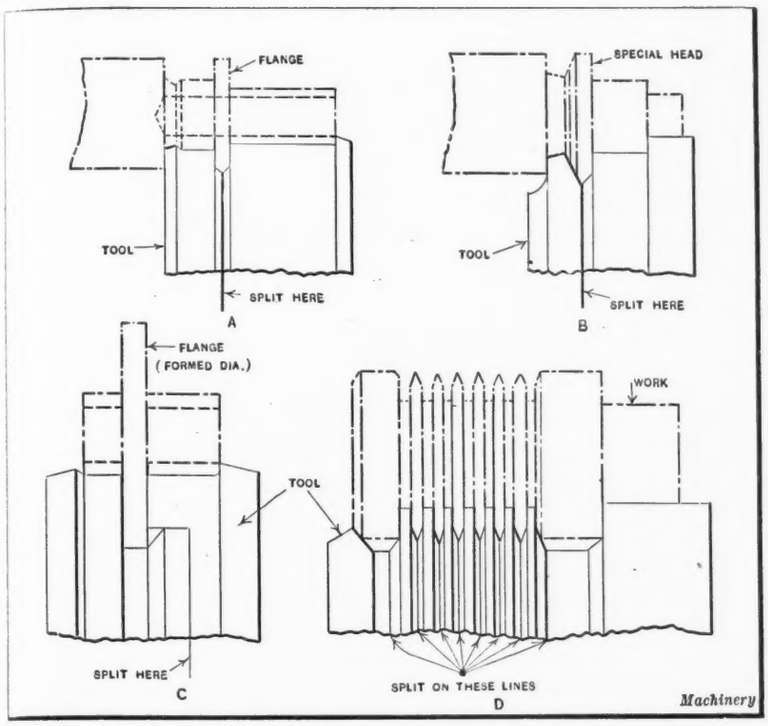



Fig. 1. Diagram showing Some Types of Split Forming Tools

universal chuck and a ⅛-inch hole drilled and reamed in its center. The bushing that had already been drilled half way through and finished on the outside was placed in the drilled hole in the casting so that the undrilled end would be presented to the drill. The drill was then fed in as before, so that it would meet the hole drilled from the opposite end.

Long Island City, N. Y. JACK HIMOFF

## DESIGN OF SPLIT CIRCULAR SCREW MACHINE FORMING TOOLS

In designing circular forming tools for automatic screw machines, a condition occasionally arises which makes it advantageous to construct the tool in two or more sections. Generally, the object of this construction is to facilitate making the tool, especially if a deep and narrow flange such as shown at *A*, Fig. 1, is to be formed or if a special head such as that shown at *B* is to be produced. Circular tools used to form the outside diameter of a flange may also be made of split construction as shown at *C*. This design has a clearance space to guard against the possibility of the stock wedging between the sections. A tool used for this purpose will, of course, be split according to the design of the piece, but the diagram indicates one construction of such a split tool. The location of the parting line on a tool of this kind will depend largely upon the method by which the tool is held in the holder. Sometimes multiple circular forming tools are required, and these can best be constructed in sections. A design of this kind is shown at *D* in Fig. 1.

If the forming of the work does not require a deep groove in the tool, it may not be necessary or desirable to make the tool of split construction. The following rule will be found helpful in deciding when split circular tools should be used: *A circular form tool should be split when the depth of tool groove is more than one and one-half times its width.* That is, if a flange is to be turned ⅛ inch wide, a split tool should be used if the depth of groove required to produce it is more than 3/16 inch. If the tool is of complicated design it may, perhaps, be better to make the tool split, regardless of the depth of the formed section. It is believed that the saving effected thereby in the manufacture of the tool would fully warrant this construction.

In the case of multiple tools and tools of more or less complicated design, there is also the question of repairs to be considered. If a tool like that shown at *D*, Fig. 1, in which the cutting sections are comparatively frail and likely to break, were made solid instead of split it would be expensive and difficult to repair. With the sectional construction, the replacing of a broken section is comparatively simple and inexpensive. The matching surfaces of split tools should generally be ground to a good fit to insure against the stock wedging between them.

The various types referred to are constructed differently, depending somewhat on the methods by which they are held in the holder. Two split circular forming tools of different designs are shown in Fig. 2. The tool at the left has one member made with a tapped hub, which furnishes sufficient bearing surface for the threaded stud by means of which this tool is held. This hub enters the hole in the other member of the tool and serves to locate the two concentrically in relation to each other. Tools of this kind, not exceeding 3 inches in diameter, are held together by three fillister-head screws and a single straight pin. Tools of larger diameter have four screws and one or more pins. When it is necessary to provide adjustment for these split tools, a number of blind holes are machined, equally spaced, at one side of the tool in which a pin-lever is used to adjust the tool.

The design shown at the right in Fig. 2 has a counterbored hole in one member to receive a bolt for holding the tool to the holder. This is a much simpler construction than that requiring machine screws, the two sections being held concentric by means of the clamping bolt and straight pins, equally spaced. The number of these pins is usually four, but varies according to the diameter of the tool.

In the case of larger diameter tools that have provision for adjustment, the blind holes previously mentioned may interfere with the pin-holes or with the screw-holes used in fastening the two members together. In such a case it is recommended that the screws be fastened in from the opposite face to that shown in the design at the left in Fig. 2.

Dayton, Ohio HAROLD P. BERRY

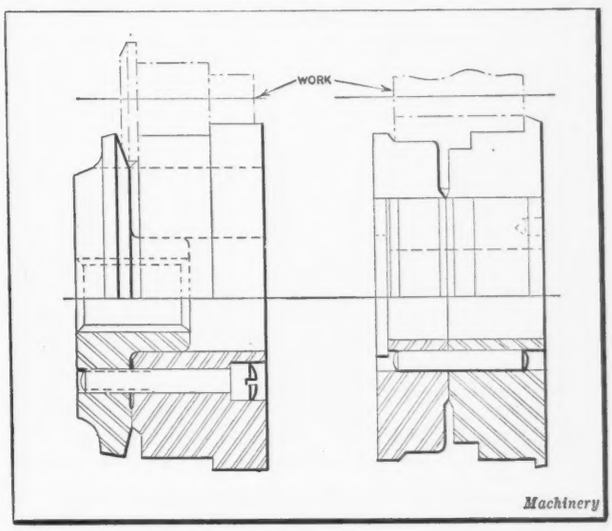



Fig. 2. Two Methods of making Split Circular Forming Tools

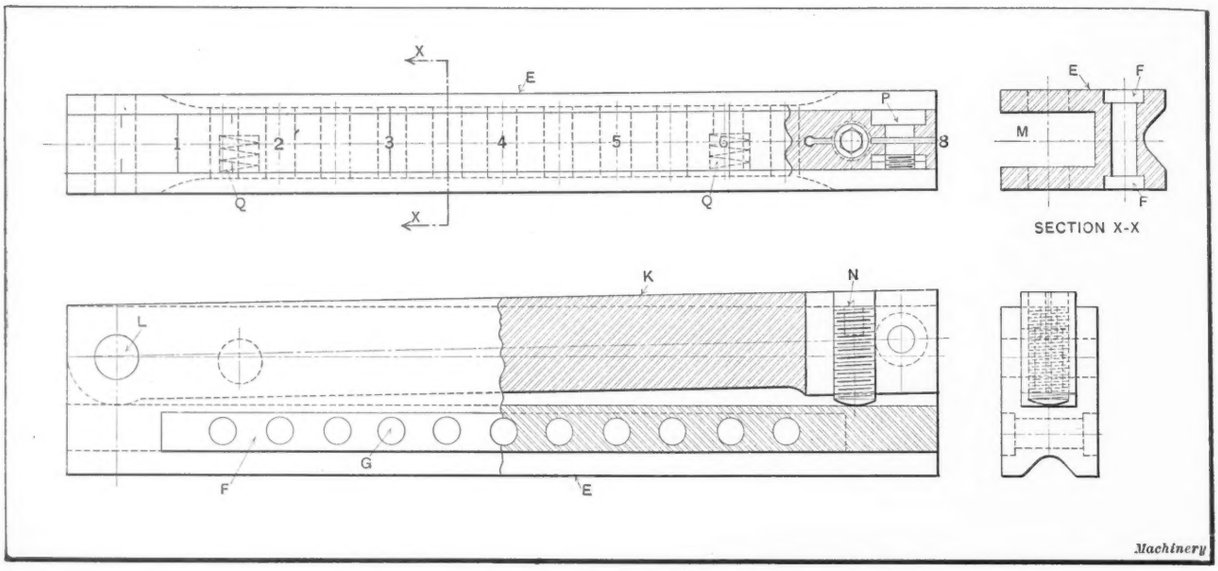



Fig. 1. Adjustable Parallel for Use in machining Tapered Work

## COMBINATION ADJUSTABLE PARALLEL AND DRILL JIG

In the manufacture of jigs, fixtures, and machine tools, it is often necessary to machine tapered pieces either in a shaper, milling machine, or planer. The writer, having noticed the difficulty frequently experienced in holding the tapered pieces designed a special parallel to facilitate this work. One of these special parallels is shown in Fig. 1. This design is as useful in a large manufacturing plant as in a small machine shop, and can be made in any size from that suitable for ordinary tool-room work to the large sizes that are required in machining heavy castings on the planer.

The top view in Fig. 1 shows a plan of the parallel, and the lower view shows the front elevation which is partly in section. A sectional view of the parallel, equipped with a special work-holding clamp *A* for milling straight or tapered keyways is shown in the view at the left in Fig. 2. The view at the right shows the parallel equipped as a drill jig for drilling pin-holes in a round shaft. In this view part *B* serves as a holder for the drill bushing *C*, which guides the drill *D*.

The body *E* (see Figs. 1 and 2) of the parallel, in the smaller sizes, is made from machine steel, casehardened and ground. The slots *F* are milled in each side of body *E* to accommodate the tongue of the fixtures shown at *A* and *B*. The holes *G*, which are drilled at regular intervals, enable the fixtures to be located and clamped in any desired position by means of the bolt *H*.

A washer *J*, of rectangular shape, is placed under the head of bolt *H*. The adjustable bar *K* is made from machine steel, and the top of the working face has graduations from 1 to 8 inches as indicated in the upper view of Fig. 1. The graduations can be made with a sharp pointed tool held in a shaper, using the graduated dials of the feed-screw to obtain the required spacing. The graduations should be deep enough to avoid the danger of their being removed at the time the upper surface of the bar is ground.

The hole at *L* should be bored out with both the pieces *E* and *K* in place. A tight-fitting plug is inserted in hole *L* to keep the two members in accurate alignment when the upper and lower surfaces are being ground. The sides of bar *K* and also the sides of slot *M* should be ground. The bar *K* has a tapped hole at the end, which receives the adjusting screw *N*. This screw is made from tool steel and is hardened. It serves as a means of adjusting or raising one end of bar *K* when it is desired to use the parallel for taper-planing.

The bar *K* has a slot 0.40 inch wide cut in its end as shown and is provided with a clamping screw *P*, which can be tightened to compensate for wear in the tapped hole or to hold screw *N* in place. Two ⅜-inch holes are drilled in the sides of bar *K* to a depth of about 5/16 inch. These holes receive helical springs *Q* that bear against the sides of slot *M*. The parallels should, of course, be made in pairs. The bottom and top surfaces of a pair of parallels should be ground at the same time on a surface grinding machine, care being taken not to remove the graduations from the surfaces of the adjustable bars in the grinding operation. Steel castings are used for the fixtures shown at *A* and *B*. in the illustration Fig. 2, and the parts *R* and *S* are made of casehardened machine steel. For heavy planer work, the body *E* of the parallel should be made of cast iron and the bar *F* should be made of machine steel but should not be hardened.

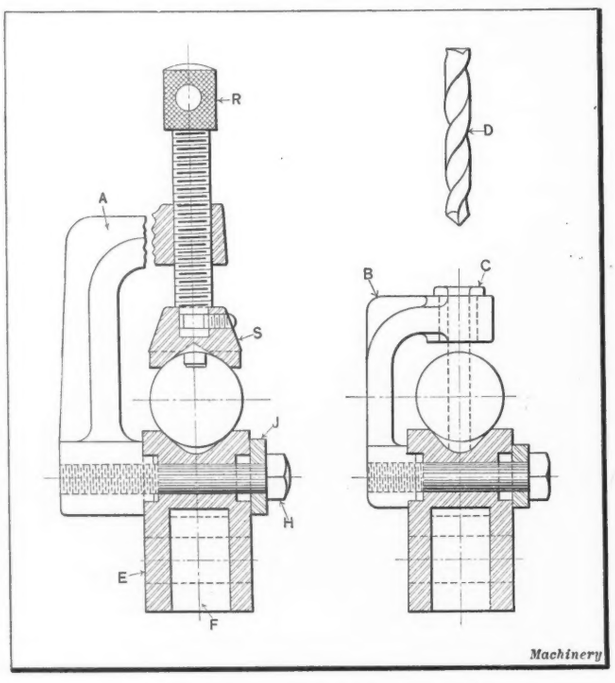


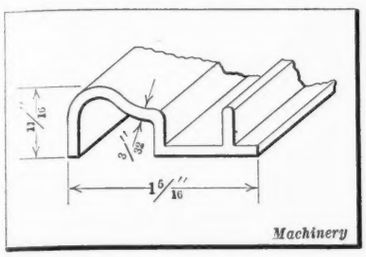

Fig. 2. Attachments for Parallel shown in Fig. 1

B. R. Wicks
Bridgeport, Conn.

# Shop and Drafting-room Kinks

## CUTTING OFF BRASS STOCK

The cutting up of large quantities of brass stock of the cross-sectional shape shown in the illustration was a problem that recently confronted the writer. The stock was to be cut into pieces 20 inches long that were to be used for sash guides on passenger coaches. After considerable experimenting, it was decided to use a high-speed metal slitting saw mounted on the arbor of a wood-cutting saw table located in the woodworking department. The saw used was 1/16 inch thick and 6 inches in diameter, and was run at a speed of 2947 revolutions per minute, which gave a surface cutting speed of 4630 feet per minute.



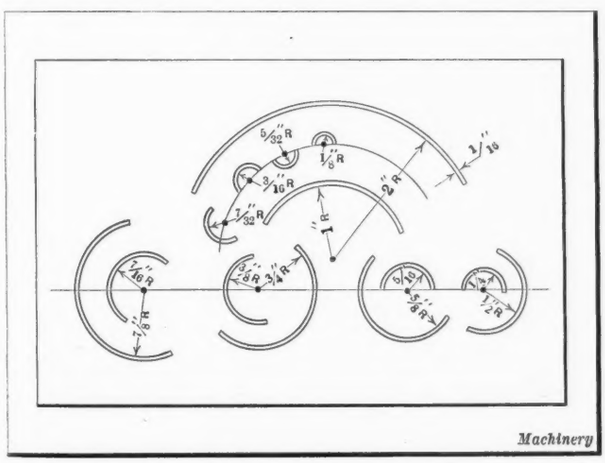

Section of Brass Sash Stock

The first trial with this equipment showed that 250 pieces could be cut off in ten minutes. On this basis of 1500 pieces per hour, less 10 per cent for rest periods, changing saws, etc., it was calculated that the production rate would be about 1350 pieces per hour. With the existing labor cost of fifty cents per hour for this class of work, the cost of cutting up the stock was $0.037 per 100 pieces. No jigs or fixtures were required.

Philadelphia, Pa. GEORGE L. LIND

## DRAFTSMAN'S FILLET TEMPLET

A templet which is made from thin celluloid with circular openings of the sizes indicated in the accompanying illustration will be found convenient for drawing fillets and round corners. The openings are cut out with the sharp points of a compass and the centers are enlarged to facilitate the location of the centers of the arcs.



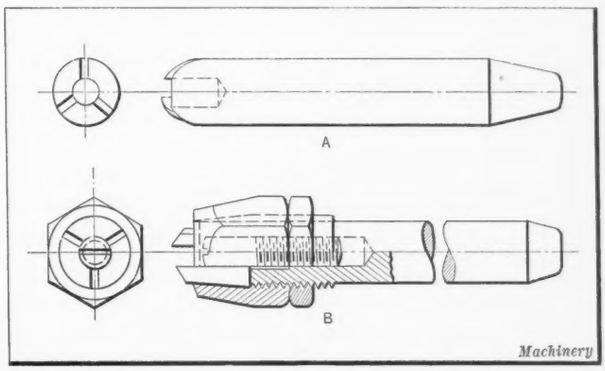

Draftsman's Fillet Templet

Detroit, Mich. GEORGE N. DORR

## STAKING TOOL WITH INSERTED BLADES

Staking tools of the type shown at *A* in the accompanying illustration were employed in assembling the parts of a time-recording device built by a well-known manufacturing concern. As the points of this type of tool broke off frequently, it was decided to make a staking tool with interchangeable blades as shown at *B*.

The tool with the interchangeable blades has two advantages over the solid blade type shown at *A*. First, it permits the blades to be hardened separately, thus lessening the danger of overheating at the points. Second, it permits the replacing of any or all blades when necessary, so that the whole tool need not be scrapped if one point is broken.



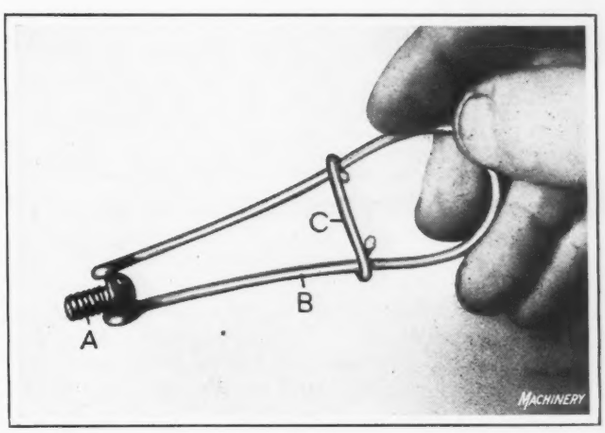

(A) Solid Staking Tool; (B) Inserted-blade Tool

Endwell, N. Y. H. KURZWEIL

## HOLDER FOR SMALL SCREWS

A holder such as shown in the accompanying illustration is of great assistance in starting small screws in tapped holes located in inaccessible places. This particular holder was used to insert screws through pads located at the bottom of a narrow slot. The pads were attached at intervals, and considerable trouble was experienced in inserting the screws in the holes with an ordinary screwdriver. By using the holder *B* all needless delay and trouble was avoided, and the work went along very smoothly. The holder is made from soft wire. Spring-tempered wire is not as satisfactory for holders of this type because the sliding piece *C* will not grip this material as well. Furthermore, no springiness is required, as the opening and closing of the jaws is accomplished by sliding piece *C* up and down. The head of the screw *A* rests snugly in place in the jaws formed by the two oval loops at the end of the holder. Quite a wide range of adjustment is obtained with the holder shown. By making the handle longer a greater range can be secured.

Rosemount, Montreal, Canada HARRY MOORE




Holder used in starting Small Screws in Inaccessible Places

# Questions and Answers on Practical Subjects

## HOW SHOULD A ROYALTY CONTRACT BE WORDED?

F. H. F.—I am negotiating with a concern that wishes to manufacture and sell, on a royalty basis, a patented invention of mine, a minimum output being guaranteed me. The concern states that it will shortly send a contract for my execution. Can you furnish a form of royalty contract that will guide me in the consideration of the one to be submitted?

A.—It is impossible for MACHINERY to furnish information regarding a royalty contract, as the conditions in each case would in all probability vary greatly, so that no one form would serve for all. MACHINERY can only undertake to answer questions on the procedure in reference to applications for letters-patent, design patents, and trademarks, in this and foreign countries, and also on the law applying thereto, but cannot undertake to deliver opinions as to the patentability of inventions or the validity of patents, nor furnish information as to the proper drawing of instruments. In cases of this character, an attorney versed in patent practice should be consulted.

## FORMULAS FOR CALCULATING SIDES OF TRAPEZOID

L. L. S.—Will you please give me a simple formula for finding the fourth side of a trapezoid when three sides and the altitude are given?

ANSWERED BY R. L. FRIESS, BOWLING GREEN, OHIO

Referring to the accompanying diagram, it will be evident that there are four cases to be considered in the solution of this problem. The formulas for each case are given in the following:

1. Given sides $a$, $c$, and $d$: In this case
$$b = d - (\sqrt{a^2 - h^2} + \sqrt{c^2 - h^2})$$
2. Given sides $a$, $b$, and $c$: Then
$$d = b + (\sqrt{a^2 - h^2} + \sqrt{c^2 - h^2}$$
3. Given sides $b$, $c$, and $d$: For this case
$$a = \sqrt{(d - b - \sqrt{c^2 - h^2})^2 + h^2}$$
4. Given sides $a$, $b$, and $d$: Then we have
$$c = \sqrt{(d - b - \sqrt{a^2 - h^2})^2 + h^2}$$

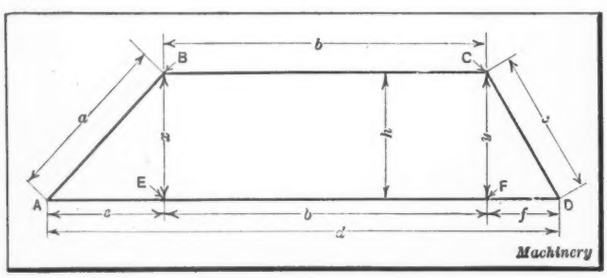



Diagram used in calculating Sides of Trapezoid

The derivation of these equations is as follows: Draw lines $x$ and $y$ parallel to altitude $h$ from the points $B$ and $C$, respectively. Then $x$ forms one leg of the right triangle $ABE$ and $y$ forms one leg of the right triangle $DCF$. Then (by construction) $x$, $y$, and $h$ are equal. Now in any right triangle the hypotenuse squared equals the base squared plus the altitude squared. Therefore we have the formulas:

$$e = \sqrt{a^2 - h^2} \quad \text{and} \quad f = \sqrt{c^2 - h^2} \qquad (1)$$

$$e = d - (b + f) \quad \text{and} \quad f = d - (b + e) \qquad (2)$$

$$a = \sqrt{e^2 + h^2} \quad \text{and} \quad c = \sqrt{f^2 + h^2} \qquad (3)$$

Then by substituting these values in their proper places according to the accompanying diagram, we obtain the four formulas given in the preceding.

## CAN A PATENT REJECTION BE APPEALED?

D. H. M.—My attorney advises that my application for letters-patent has been finally rejected. I have examined the patents cited by the patent examiner in his rejection of my application, and do not see in what respect they meet my invention. Have I any appeal?

ANSWERED BY GLENN B. HARRIS, YONKERS, N. Y.

Your attorney, if competent, should be in a position to advise whether the patents cited against your application are pertinent, and should know what action to take in the matter. While it is possible that the patents referred to by the examiner in the rejection of your application do not meet your invention, it is probable that the wording of the claims in your specification is so broad that the terms are met by the other patents. If your claims were limited to the differences existing between your invention and the references cited, and if the advantages of your invention over these references were clearly set forth, the examiner might reconsider his action, provided your contentions are well founded. Should the examiner refuse to reconsider his rejection of the application, there is an appeal to the Board of Examiners-in-Chief, and from its adverse decision to the Commissioner of Patents, in person. Should the commissioner's decision also be against you, an appeal may be made to the Court of Appeals of the District of Columbia.

## CUTTING ANGLES FOR BEVEL GEARS

J. H. B.—Dies are to be made for casting white metal bevel gearing of 16 pitch and having 32 and 12 teeth for the gear and pinion, respectively. These dies are to be cut on a milling machine by the following method: A singled toothed cutter is to be used. The cutter will remain stationary and the operation will be one of planing rather than of milling, owing to the particular conditions in this case. In MACHINERY'S HANDBOOK, pages 627-631, is given a table which may be used for finding the cutting angles of bevel gears. This table, according to an explanatory note, is for rotary cutters. Does the method of cutting a bevel gear affect the cutting angle?

A.—When bevel gears are cut on a generating type of machine, which gives a theoretically correct tooth, the cutting angle equals the pitch-cone angle minus the dedendum angle, but when they are cut by using a rotary formed cutter, it is preferable to obtain the cutting angle by subtracting from the pitch-cone angle the addendum angle instead of the dedendum angle. When the addendum angle is subtracted, a somewhat closer approximation to the required tooth form is obtained with the rotary cutter, which, at best, does not give the tooth the correct shape throughout its length. While the teeth in the dies referred to are to be formed by planing, this is not, of course, a generating process, and the method of cutting gives practically the same result as the rotary method, so far as accuracy is concerned. Consequently, the cutting angle in the case under consideration should be obtained by subtracting the addendum rather than the dedendum angle.

# The British Metal-working Industries

From MACHINERY'S Special Correspondent

London, November 13

DURING the last two months improvement has been more generally noticeable in the metal-working industries. Unemployment is declining, though very slowly, but workers are being absorbed in several directions, and this would indicate that the improvement is not due to exceptional activity in only one or two trades. At a rough estimate it may be said that engineering plants are averaging about 30 per cent capacity. Several trades, however, can show quite good figures, and as an example, tube works may be cited as working full time. Many such works have sufficient orders in hand for a twelve months' output at the present rate of production. This general improvement in the engineering industry is due largely to overseas trade, and home demand still fluctuates.

### Improving Demand for Machine Tools

In the machine tool industry, business remains quiet, but contrary to some other lines inquiry for the home market is a fair proportion of the whole. France is a good buyer of light manufacturing tools, considering the position as a whole, and one firm is reported to be doing a certain amount of business in Germany with gear-cutting machines. A firm in the Midlands, after a gradual expansion since the lockout, is now engaged at about 50 per cent capacity. At present there seems to be a fair demand for milling machines, and a number of promising orders for tools of this type have been placed recently.

In other shops a number of heavy-duty machine tools are in course of construction for the home and Colonial Railways, including boring mills, and wheel- and tire-turning lathes. Several special machines for the electrical trades are also in hand. As a rule, however, makers of this class of machine are not by any means busy, although it is understood that the prospects are much brighter. There is plenty of inquiry from abroad, and there are signs that the home railways will resume buying in the near future.

Several well-known machine builders have placed new designs on the market during the last month. A Halifax firm has in hand a large order for a gang of girder radial drilling machines for use on the 60,000-ton floating dock being built for the London and South Western Railway Co. by Sir W. G. Armstrong Whitworth & Co., Ltd., Newcastle-on-Tyne.

The demand for small tools is well maintained, and in some quarters manufacturers are working up to full capacity. The overseas trade in small tools is good, Australia being particularly prominent as a buyer. Grinding whe manufacturers are also busy. In fact, one well-known Midland firm is busier than at any previous time in its history.

### The Automobile Industry

In the automobile industry preparations are being made for the coming season. At the annual motor show now being held at Olympia and the White City, several new designs of light cars to carry three or, at the most, four people are shown for the first time; the prices range from £180 to £250, and it is expected that a hitherto untouched market will now be drawn upon.

Another development in the automobile industry is the decision of some makers who up to now have specialized on one model powerful car of the highest grade, to undertake the manufacture of a smaller powered car at a moderate price. The Rolls Royce Co. is among such makers, and the firm expects to have a car of this type on the market by the end of the year.

### Overseas Trade in Machine Tools

For the second consecutive month an increase is noted in the exports of machine tools. Although not so big as the increase in August, this is the first occasion for more than a year that the promise of one month has been continued through the next. An export tonnage of 819 with a value of about £105,700 in August rose to 835 tons with a value of £115,700 in September. Imports showed a decline in September to 231 tons with a value of £34,410 from 431 tons and a value of £56,604 in August. The value per ton of exports rose from £129 in August to £131 in September, and that of imports rose from £131 to £149.

This year the highest point in exports of machine tools was reached in April, with a tonnage of 1400. From then until the end of July a sharp and continuous fall occurred, and only 500 tons were exported during July. To bring this year's exports up to the pre-war average in weight 4000 tons would have to be exported in the three last months; and only a considerable spurt of trade can realize this. The average price per ton of exports is, however, more than double the pre-war rate, and as this is a bigger increase over pre-war prices than is noted in the prices of machines sold in this country, it points to the fact that the exported goods are on the average in a more valuable class than was formerly the case. Imports remain at almost pre-war level.

### Labor Conditions

Employment in the engineering industries during September showed little change on the whole, as compared with the previous month. The position on the north-east coast remains bad, as it also does in the Lancashire districts, with the exception of the textile machinery makers, some of whom still report over-time. The percentage of registered unemployed in the engineering industries for September was 22.9—a total of 261,062—the August figures being 258,830, or 22.7 per cent.

### Materials and Prices

The production of pig iron in this country in September was 430,300 tons, and of steel ingots and castings 555,900 tons. In both cases these figures are greater than during any month since the coal strike in 1921. They represent, however, a production of only 60 to 70 per cent of that during 1920, and much of the material went to America to meet the abnormal conditions there due to strikes. Railway rates are still a great stumbling block to the expansion of the iron and steel industries and in some cases are still more than 80 per cent over those prevailing previous to the war.

Finished steel prices are still steady; mild steel plates ⅜ inch thick and up remain at £9 to £9 5s. per ton and pig irons also show little variation, ranging in price from £3 17s 6d to £4 12s 6d per ton according to grade. Machine tool gray iron castings up to 5 tons in weight are being sold in the Birmingham district for 20s to 21s per hundredweight, while light castings bring 27s per hundredweight. In the Manchester area, founders are quoting from 24s 3d per hundredweight up to 43s 6d for machine tool castings, these prices varying according to size and number.

# The Machine-building Industries

DOES the general industrial outlook justify optimism and confidence? This question a great many executives ask themselves every day. The Federal Reserve Bank of Cleveland answers that "the business tide is rising. The receding tide has carried out most of the wrecks of business; the incoming tide is raising the tide line of business." The Federal Reserve Bank of Chicago says: "General business improvement is manifested in reports from all sections, and in practically all phases of industry. Moderate increases in the volume of employment reflect a general speeding up of production." The Department of Commerce states that "the most important development of recent weeks is the marked increase in the demand for goods. Increased employment and higher wages have been largely responsible for this increased demand."

First-hand information collected by MACHINERY from the machine-building industries bears out these statements. The machine tool industry shows steady improvement; the activity in some of the plants manufacturing shop accessories and tools has reached a normal level. The machine tool shops, as a whole, are working at an average of nearly one-third capacity; several plants have exceeded the 50 per cent mark, and a few are doing almost a normal business. The output of the automobile industry continues unusually high for this time of the year. As a consequence, many of the industries depending mainly on the automobile shops for an outlet are operating at capacity. Power plant equipment is in demand. The electrical industry is keeping step with the general improvement in business. Additional equipment has been ordered by many public utility corporations, to take care of the rapidly growing demand for electricity, a demand which is not confined to any particular locality, but is spread over the entire country. The hoisting machinery industry operates at about 50 per cent capacity. Turning from heavy machinery to light manufacture, we find the typewriter plants fully occupied. The same is true of the hardware factories. The activity in the metal-working field has not been exceeded since the early part of 1920.

### The Machine Tool and Small Tool Industries

Referring specifically to conditions in a number of machine tool plants recently visited, we find one plant that builds automatic machinery doing a 70 per cent business; one of the leading lathe builders operates at about the same percentage of normal; and two other lathe manufacturers at from 50 to 60 per cent. A manufacturer of hammering and riveting machinery is doing a business equal to 80 per cent of normal. Several manufacturers state that October brought more business than any month since early in 1920.

In the accessories and small tool fields, conditions are encouraging. Two manufacturers of lathe chucks state that their business is about 50 per cent of normal, and that there is now some export business in this field, mainly to England, Australia, and Japan. The domestic business in chucks is not yet as active as it would be if there were not still large stocks of chucks in the hands of both dealers and manufacturers who use them as regular equipment on their machines. One manufacturer of chucks finds the business particularly quiet on this account. The drill chuck business is quite active, and at least one of the manufacturers in this line operates at capacity. There is a fair export business in drill chucks, mainly to England and Japan. The demand for drop-forged tools is good, except in lines where large quantities were put in stock by manufacturers and dealers two years ago. Generally speaking, the demand for small tools is considerably above the pre-war level.

In allied industries there is also a decided improvement. Shops engaged in making pyrometers and other heat-recording instruments see better business ahead. The screw products business is good, and some of the plants in this field are working over-time. Prices for screw products were too low to meet costs a year ago, but have now reached a more satisfactory level. The silent chain business is active, and will doubtless continue to be as long as the automobile business continues as at present. Some of the companies making abrasives and grinding wheels work nearly to capacity.

### The Automotive Industries

Contrary to expectations, the automobile industry has continued to work almost at capacity throughout the fall months. The October production of cars and trucks amounted to about 244,000, compared with 206,000 in September. It was expected that the figures for November would be considerably less, but no signs of decreased production are as yet visible in the larger factories. At present, it appears that the automobile production for 1922 will exceed the record of 1920, which was 2,200,000 cars.

In the truck business, the principal demand at this time is for light trucks, of from ½ to 1½ tons capacity. One well-known manufacturer of trucks states that the present demand for this type of truck is greater than at any time in the past. Manufacturers of industrial tractors and trucks for handling heavy materials also report good business.

The farm tractor industry has shown a substantial increase, compared with 1921, and the production schedules that manufacturers are now preparing for 1923 are much larger than those for the last two years. Several companies have made greater shipments during the last two or three months than ever before, and others state that the business done approximates that of a normal year. As stated, industries that depend directly on the automobile business are also working at capacity, like ball and roller bearing manufacturers, gear and axle manufacturers, and chain makers.

### The Iron and Steel Industry

Unless the iron and steel industry is in a healthy state, the other metal-working industries cannot be expected soon to return to a normal state of business. The steel production is increasing, and the mills of the United States Steel Corporation are now operating at 78 per cent capacity, with the industry as a whole working at from 70 to 75 per cent. The greatest difficulty this industry is confronted with at the moment is the necessity of accumulating adequate coal reserves for the winter. Buyers seem inclined to wait for lower prices, but under existing conditions it is doubtful whether any material price reductions will be made.

### The Employment Situation

The increased activity in the principal industries has resulted in a shortage of labor in many parts of the country. In New York state, for example, there are now 160,000 more people employed in factories than there were a year ago, and the number of employes is now larger than in 1914. Marked gains are especially noticeable in iron and steel plants and in the metal-working shops generally. There is a scarcity of skilled machinists which will spread as the machine-building industries become more active. This will influence the wage rate, and make it necessary for manufacturers to adjust their prices in keeping with the increased costs of materials and labor. Machine tool prices are now probably as low as they will be for a long time to come, and any change will mean an increase rather than a decrease.

# New Machinery and Tools

**The Complete Monthly Record of New Metal-working Machinery**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## Bullard Pipe Coupling Boring Machine

OIL-well casing or pipe couplings can be simultaneously taper- and straight-bored, faced and chamfered on both ends in a large horizontal type machine which has been developed by the Bullard Machine Tool Co., Bridgeport, Conn. During this operation the coupling is held stationary between two pneumatically operated jaws which, with an air pressure of 80 pounds per square inch, exert a pressure of 12,000 pounds on the work, thus insuring a positive grip which holds the coupling firmly under the heavy cutting action of the tools. When the operation is completed, the jaws open, the finished coupling is ejected, a new piece rolls into place, and the jaws are closed again. The entire operation of the machine is automatic, the attendant being required simply to place the work on a chute at the rear of the machine. The heavy lines in Fig. 4 indicate the surfaces that are finished, both ends being identical. It will be seen that there is a long taper-boring operation up to the middle of the coupling, a straight-boring or recessing step for a short distance at the end as well as facing and chamfering cuts.

### Construction of Tool-heads

From Figs. 2 and 3, which show front and rear views of the machine, respectively, it will be seen that there are two opposing heads of similar construction. A holder having eight cutters is mounted on the front of each head. Two cutters are supplied for each surface machined, those for chamfering and facing being mounted on the faceplate of the cutter-head, while those for taper-boring and recessing are mounted on the cylindrical part of the cutter-head. The heads have a rapid traverse to the point of cutting, a slow feed during the cutting, and a rapid traverse for the return. An ingenious mechanism provides for feeding the taper-boring tools radially to suit the amount of taper. A square-section guide or former bar extends through the spindle of each head and the holders for the taper-boring tools slide on the sides of this bar. Two of the sides are tapered to conform with the coupling, and thus feed the tools radially as they are advanced into the work. When either head starts to advance, the former bar is pushed forward by means of a lever mechanism at a much faster rate than the head, so that by the time the head begins its slow feeding movement the bar is stationary. When the operation is completed the bar is pulled back with the head to enable the work to be removed, which would otherwise be prevented as the former bars project, at this point in the operation, almost to the center of the work-holding jaws.

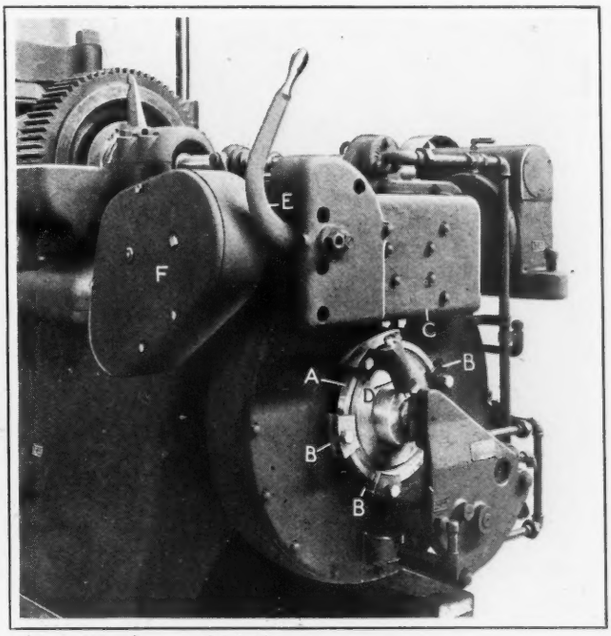



Fig. 1. Timing Mechanism which controls the Movement of the Heads and the Operation of the Work-holding Jaws on the Bullard Pipe Coupling Boring Machine

The right-hand head advances slightly ahead of the other and returns slightly before it. This is necessary in order that the taper surfaces may be cut to the center of the coupling from each side without the heads interfering with each other. The cutter-heads revolve in opposite directions, and are both driven from the motor on top of the machine at the left, which drives through spur gears and a shaft at the rear to the right-hand head, and through a shaft at the front to the left-hand head. The horizontal movements of the

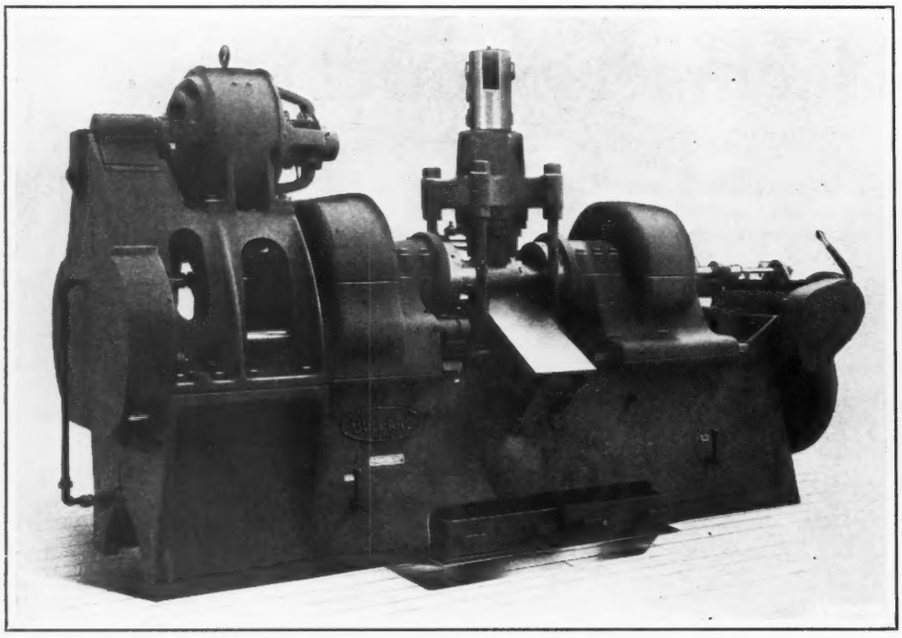


Fig. 2. Bullard Boring Machine for Oil-well Casing or Pipe Couplings, which functions automatically

heads are controlled by two barrel cams in the bed. The shaft on which these cams are mounted is driven from the motor on top of the machine through change-gears for feeding the heads during the cutting period, the drive being transmitted through the shaft which furnishes power to the spindle of the right-hand head. However, for the rapid traverse, the camshaft is driven by an auxiliary motor at the rear of the machine, through large proportioned worm-gearing.

The former bar of each head may be quickly removed so that another can be substituted, this being essential because the taper bore may vary with different couplings. The tool-heads may also be quickly removed from the spindle ends when a coupling of a different diameter is to be handled. The cutters are ¾-inch square tool bits and can be independently adjusted or removed from the holders. Cutting compound is pumped to the work during the cutting period through a hole running the length of the former bars. The cutting compound drains from the work to a reservoir under the bed, from which it is strained and repumped to the cutting tools.

### Timing Mechanism

The feed and rapid traverse movements of the heads are controlled by a timing mechanism at the right-hand end of the bed, which is shown in Fig. 1. Disk *A* is mounted on the camshaft and carries three blocks *B* which have projecting pins that alternately trip two interlocking levers projecting from clutch box *C*. The movement of these trip-levers shifts clutches in this box so as to rotate the camshaft slowly or quickly for the feeding and rapid traverse movements, respectively, of the tool-heads. It was stated in the preceding that when the camshaft is revolved slowly it is driven from the motor on the top of the machine, and when it revolves at the fast rate it is driven by the motor at the rear. Bracket *D*, also carried on disk *A*, has a plunger which opens and closes an air valve at the proper moment for supplying air to the cylinder of the work-holding jaws and for cutting off this supply.

The timing mechanism gives the following cycle of movements to the camshaft: A fast rotation during which the heads are traversed forward to the cutting point, a slow rotation while the heads are fed forward during the cutting period, and a fast rotation during which the heads are traversed back to the starting point. The work-holding jaws are opened simultaneously with the rapid return of the heads, and are closed simultaneously with the forward rapid traverse. There are three positions for handle *E*: When it is all the way down, the heads operate back and forth only at the rapid rate, this being convenient in setting up the tooling for a job; when the lever is in the neutral position, the machine runs with the heads stationary, so far as longitudinal movement is concerned; and when the handle is in the upper position, the machine functions normally. The rate of feed may be changed within certain limits by means of change-gears in box *F*. The position of blocks *B* may be adjusted around disk *A* to vary the lengths of the rapid traverse and slow feed movements of the heads in accordance with the length of the coupling being handled.

### Operation of the Work-holding Jaws

The couplings are placed on the chute seen at the center of the machine in Fig. 3, where they are held from rolling by

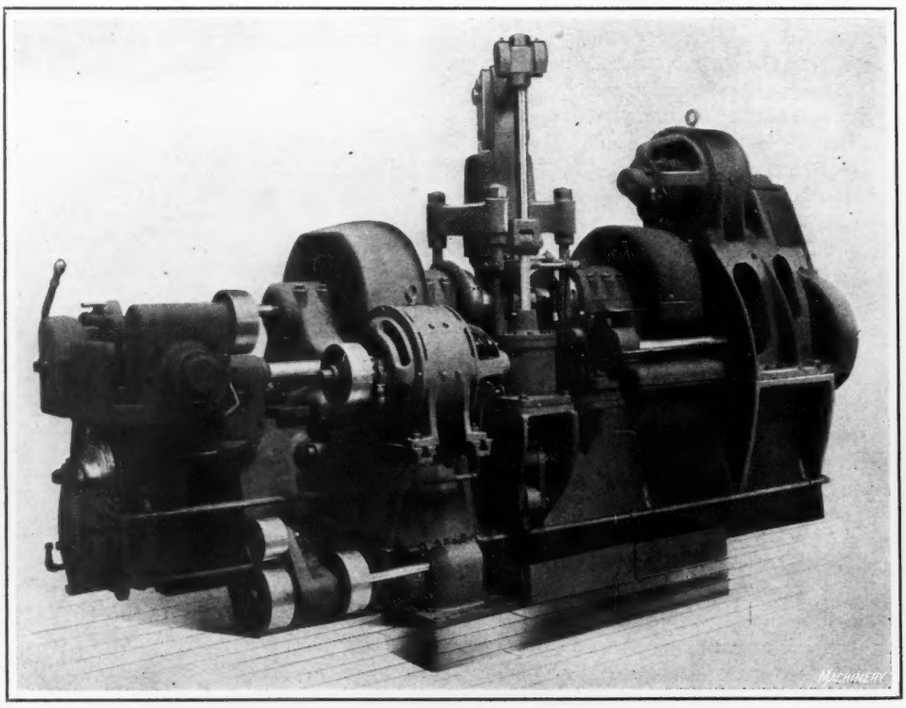


Fig. 3. Coupling Boring Machine from the Rear, showing the Pneumatic Opening and Closing Arrangement for the Work-holding Jaws

means of two vertical pins while another coupling is being clamped between the jaws. However, when the heads are withdrawn at the completion of an operation, air is supplied to the releasing end of the cylinder, as mentioned in connection with the timing mechanism, to actuate the toggle mechanism so that it raises the upper jaw and lowers the bottom one. Simultaneously with the jaw movements an ejector rises in the bottom jaw and lifts the coupling so that it will roll down the chute at the front of the machine into a receptacle. At the same time the vertical pins that hold the unfinished work on the rear chute are lowered to allow the next coupling to roll forward between the jaws, where it is located both radially and endwise. When the work is in place, the jaws are again brought together by the operation of the air valve through the timing mechanism.

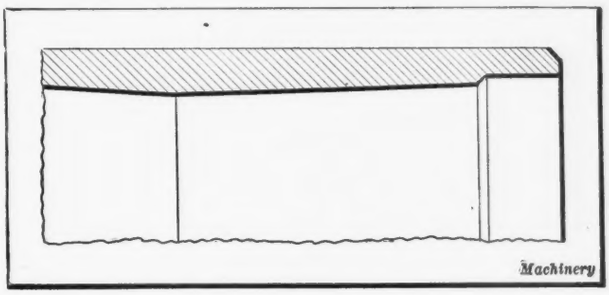



Fig. 4. Diagrammatic View, showing the Cuts taken on Each End of a Coupling

The main transmission gears are made of alloy steel and are heat-treated, and the feed-cams are made of steel. A large ball bearing takes the spindle thrust in each head. Special attention was paid in designing this machine to provide adequate lubrication; the tool-heads contain reservoirs in which the driving gears revolve, and there is a provision for carrying oil to the main spindle bearings. Both the feed-cams are also immersed in oil. The motor on top of the machine should be of the variable-speed type and have a capacity of from 10 to 25 horsepower, depending on the size of the coupling to be handled. The auxiliary motor which drives the power traverse and cutting compound pump should be of 5 horsepower capacity. The main driving motor should be equipped with a magnetic remote control for starting and stopping the machine.

### Specifications

Some of the important specifications of this boring machine are as follows: Minimum and maximum diameter of coupling that can be machined, 5 and 12½ inches, respectively; maximum length of coupling, 12¼ inches; total movement of each tool-head, 9½ inches; minimum and maximum revolutions per minute of boring spindles, 10 and 40, respectively; feed range of tool-heads, from 0.025 to 0.075 inch per spindle revolution; and weight, 24,000 pounds.

## NILES-BEMENT-POND HEAVY-DUTY ENGINE LATHE

A heavy-duty engine lathe having a swing of 60 inches has recently been added to the line of machine tools built by the Niles-Bement-Pond Co., 111 Broadway, New York City. This lathe is shown in Fig. 1, equipped with a constant-speed motor of forty horsepower capacity; with this drive, twenty-four faceplate spindle speeds may be obtained through speed change-gears which are operated by manipulating levers on the headstock. When the machine is equipped with an adjustable-speed direct-current motor as illustrated in Fig. 2, the speed range of the motor is such as to permit the change-gears in the part of the headstock above the joint line to be omitted without reducing the range of spindle speeds. The motor may be started and stopped by operating a handle on the carriage, and when the machine is driven by the adjustable-speed motor, any spindle speed within the range of the motor can be obtained through the same handle. A push-button on the headstock permits of jogging the motor to enable quick and easy shifting of the speed change-gears.

The headstock is of a substantial design, and is entirely enclosed. All bearings and gears are continuously oiled by means of a pump which supplies filtered oil to a large reservoir in the upper part of the headstock from which the oil is distributed by pipes to each member requiring lubrication. The surplus oil drains into a settling tank in the base of the head, from which it is pumped through a filter and back to the reservoir. The spindle bearings are fitted with oil distributing rings and have large oil-wells to furnish lubricant in addition to the continuous oil supply. The faceplate has four pairs of parallel slots for the attachment of steel jaws. The center is made of tool steel, is hardened and ground, and is fitted with a large spanner nut to facilitate its removal.

The tailstock spindle is also made of tool steel, and provided with a spanner nut. It is of ample diameter to insure stiffness when run out the maximum amount. This spindle is adjusted through gearing and a handwheel, which is located at an angle relative to the axis of the spindle,

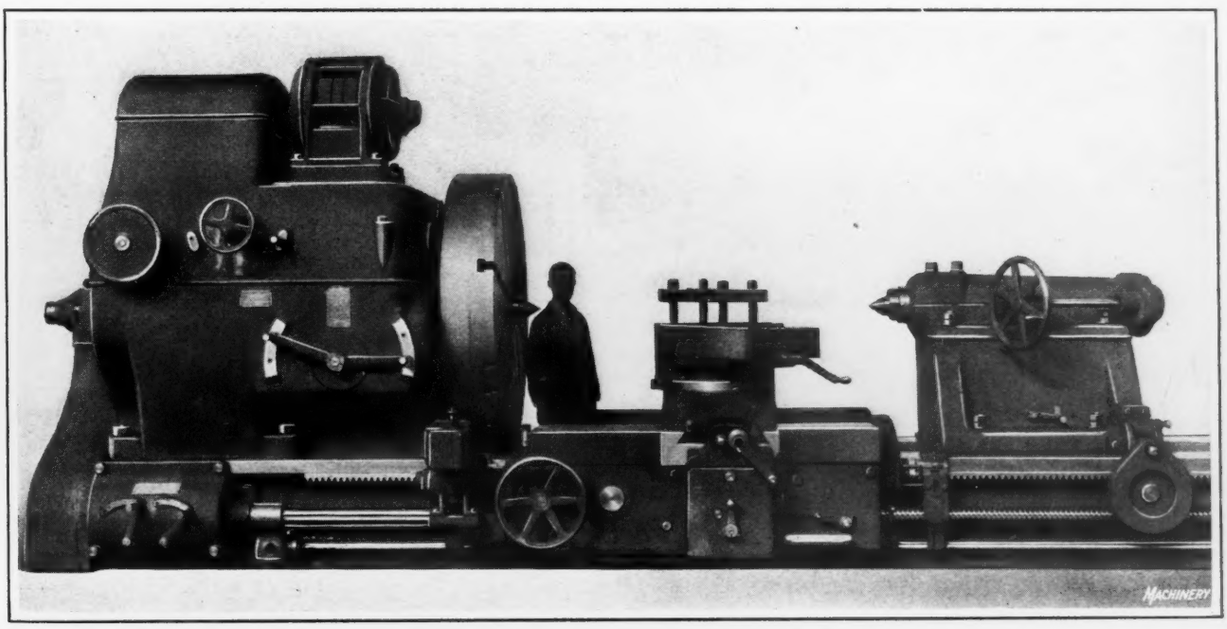



Fig. 1. Niles-Bement-Pond Heavy-duty Engine Lathe which has a Swing of 60 Inches

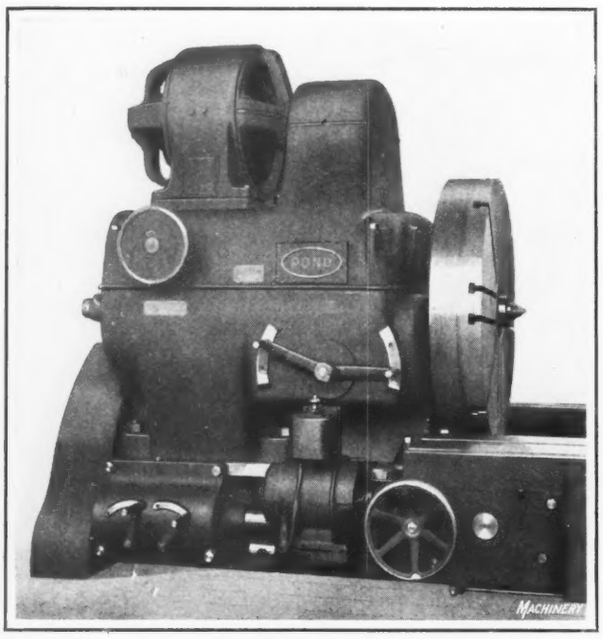


Fig. 2. Engine Lathe equipped with an Adjustable-speed Driving Motor

in a position especially convenient for the operator when placing work between the centers. The upper part of the tailstock can be adjusted crosswise by means of a screw, for turning slight tapers. This part of the tailstock is clamped to the lower section by bolts which are independent of the bolts that clamp the lower section to the bed. The latter are supplemented by a pawl which engages a ratchet on the bed to prevent slipping of the tailstock under a heavy end thrust. The pawl may be lifted out of engagement with the ratchet by the handle on the front of the tailstock. The ratchet is made in sections which are readily removable to allow chips that may accumulate in the bed to be cleaned out.

The tool carriage has longitudinal, cross, and angular feeds both by power and by hand. A rapid traverse along the bed is also provided through a five-horsepower motor and drum switch mounted on the carriage. The switch has a spring return to the off position. The apron is of the one-piece type, with all gears enclosed and all shafts having a bearing at each end. The gears and bearings are oiled from a reservoir filled at the top of the carriage. The direction of any feed may be changed, started, or stopped at the carriage, the operating levers being conveniently located and so interlocked that no two feeds can be engaged at the same time.

The thread of the lead-screw is used only in cutting threads, the carriage being fed for other work by a spline in the lead-screw. All feeds are obtained through a quick-change gear-box, which gives four feeds for turning, facing or thread-cutting without removing gears. Other feeds may be obtained by means of change-gears at the end of the headstock. When the lathe is built with a long bed, the lead-screw and controller shaft are supported at intervals by bearings which are automatically spaced by the carriage. This lathe is supplied with a five-jaw steadyrest.

## MIDWEST STEEL BOX-RAILS AND STRINGERS

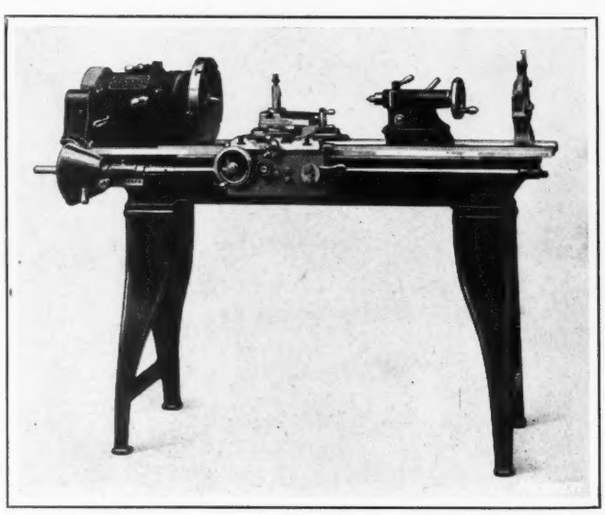
Rolled-steel box rails and stringers for attaching machinery, motors, lineshafts and countershafts, crane rails, pipe lines, sprinkler systems, etc., securely to ceilings, walls, or floors, are now being manufactured by the Midwest Steel & Supply Co., Inc., 28 W. 44th St., New York City. The box-rails are usually built into the ceilings or walls of concrete buildings during their erection, only a surface slot of the rail being left exposed. The anchorage of equipment to the box-rail is accomplished by simply slipping a special bolt into the slot at any point, and turning the bolt through 90 degrees. In the store-room the box-rails are especially useful in attaching brackets to the walls for supporting bar stock. The steel stringers are primarily intended for machine and transmission installations, and are readily attached to wooden or steel girders. Both the box-rails and stringers are furnished in various lengths.

## OLIVER ENGINE LATHE

The engine lathe shown in the accompanying illustration is an addition to the line of machine tools built by the Oliver Machinery Co., Grand Rapids, Mich. The new lathe is made in three sizes, namely, 10, 12 and 14 inches swing, respectively. It may be equipped either with a single driving pulley and geared headstock or with a back-geared three-step cone-pulley headstock. Both types of heads may be motor-driven. The lathe may also be supplied with either a straight or a gap bed and with bench or floor legs. Six spindle speeds are obtainable with the geared headstock through two levers located at the front. One of these operates a positive clutch to engage either the back-gears or the direct drive, while the other shifts three gears and thus provides three speeds through the direct drive and three through the back-gears.

The driving pulley is fitted with a friction clutch which is operated by means of a bar that extends the length of the lathe. This clutch enables the spindle speed to be changed and the lathe to be started or stopped during an operation without stopping the motor or the driving belt. The headstock is equipped with a tooth clutch by means of which both the longitudinal and cross feeds may be instantly reversed without shifting gears or belts, reversing the spindle rotation, or stopping the lathe. This feature simplifies the cutting of threads and decreases the time for such operations. The screw of the tailstock is set over for taper-turning and the spindle is graduated in sixteenths of an inch for convenience in drilling to depth.

The carriage has a positive lock to prevent longitudinal motion while a cross cut is being taken. The back of the carriage is drilled and tapped to receive a taper attachment and a follow-rest, and has T-slots at the front and rear for attaching jigs, fixtures, or other special equipment. The swiveling bar of the taper attachment is graduated in inches, and tapers up to 4½ inches per foot may be turned. The cross-slide screw has a dial graduated in thousandths of an inch. The base of the compound rest is circular and is graduated in degrees to permit accurate settings to be made



Oliver 10-, 12-, and 14-inch Engine Lathe equipped with Geared or Cone-pulley Headstock

at any desired angle. The compound-rest screw is also fitted with a dial graduated in thousandths of an inch.

The apron gearing is so arranged that the operator may readily change from thread-cutting to a job in which the longitudinal or cross feed is used, without shifting gears. The difference between the lead in chasing threads and that desired in feeding the carriage for turning or facing is made possible by worm-gearing. The feed-lever on the apron has three distinct positions: In the first position it engages the power longitudinal feed; in the second position it is neutral and permits the engagement of the lead-screw; and in the third position it engages the power cross-feed.

## CINCINNATI-ACME HAND MILLING MACHINE

For milling straight or taper squares on steel or brass parts, the Acme Machine Tool Co., Cincinnati, Ohio, has developed the hand-operated machine here illustrated. This machine is provided with two independently driven spindles mounted in headstocks. The inner end of each spindle has a No. 9 B. & S. taper hole to receive milling cutters, and is slotted across the face to accommodate the driving tang of the cutters. Both headstocks may be swiveled to suit the milling of either straight or taper squares, such settings being accurately accomplished by means of graduations. The heads are mounted on slides which have a longitudinal adjustment along the bed, the adjustment being accomplished by the handwheels at the ends of the machine. These handwheels are provided with micrometer dials to permit close adjustments to be made.

The bed carries a vertical slide on which the work-holding fixture is mounted, and adjustable gibs are provided to compensate for wear. The work-holding fixture is similar in design to an automatic spring collet chuck. The work is inserted from the front of the machine, and when a part has been located in the fixture, it is clamped in place by giving a slight rotary movement to the four-spoke handle. The chuck is then free to revolve, but before raising it to feed the work past the cutters, it is locked in position by means of a hardened and ground bolt which may be set in four positions. In addition to the vertical movement of the work-holding slide, it has a movement at right angles to the spindles.

Downward motion of the long lever at the front of the machine causes the slide to pass the work between the milling cutters, the two sides of a square thus being milled simultaneously. The slide is then withdrawn, and during this movement, the locking bolt in the work-holding fixture is also automatically withdrawn. The operator may then revolve the chuck with his left hand, keeping his right hand constantly on the vertical-slide operating lever. This slide is counterbalanced to allow it to move equally freely in both directions. At the end of an operation the four-spoke handle is given a partial turn to the left in order to open the chuck. In the rear view of the machine shown in Fig. 2, there may be seen at the center of the bed a small slide on which is mounted an adjustable stop, against which the work is brought to insure that all pieces will be held alike as regards the length of the square. This view of the machine also shows the arrangement of the pump for supplying coolant to the cutters. The machine is designed to be driven from a plain countershaft, and when necessary, two speeds can be provided for.

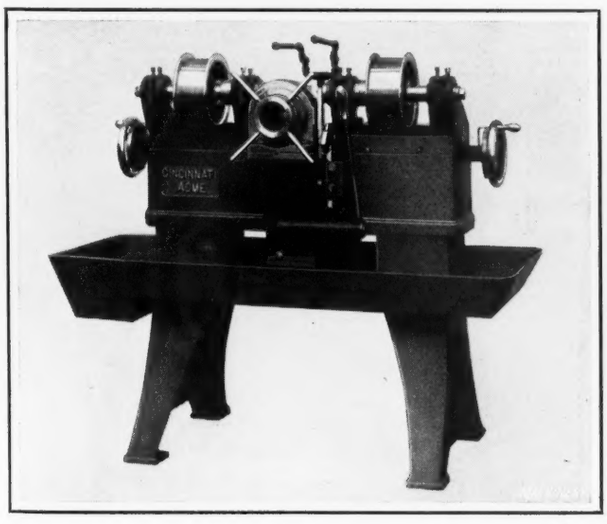


Fig. 1. Cincinnati-Acme Hand-fed Machine for milling Straight and Taper Squares

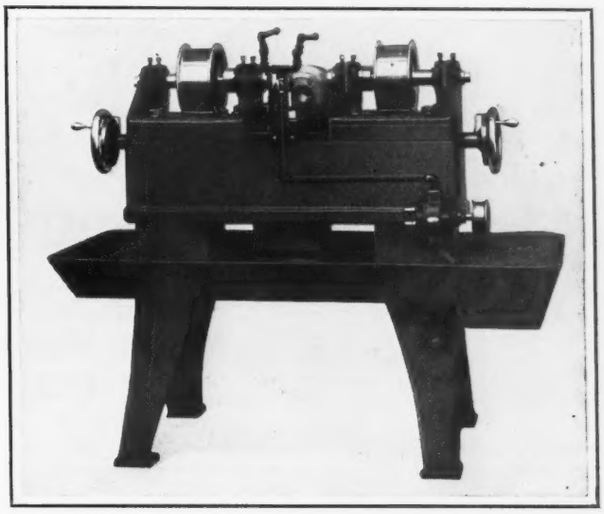


Fig. 2. View of Machine from the Rear, showing Slide on which the Adjustable Work Stop is mounted

## PRATT & WHITNEY GAGES

Recent additions to the line of gages manufactured by the Pratt & Whitney Co., Hartford, Conn., include a gage for determining the amount of metal that must be removed from the steel tire of a railway wheel to restore the tire to the standard contour; a double-plug pipe-thread gage; and an adjustable limit-pin gage for internal measurements. The tire gage is known as the A. R. A. railway gage, and in addition to the measurement already mentioned, it indicates the amount of service metal that will remain on the worn tire after it has been trued. This gage is illustrated at the left in Fig. 1. In using it, pointer *A* is swung to the right, the gage slipped over the wheel with face *B* and point *C* in contact, point *A* swung to the left to engage the limit-of-wear groove in the tire, the four sliding points pushed down on the tire tread, and the gage removed from the wheel.

The sliding front plate of the gage is then moved downward until edge *D* coincides with the lowest point of the four sliding pointers. The position of scribed line *E* with respect to the grooves on the front plate will then indicate the amount of metal that must be removed from the tire at point *C* in order to restore the tread to the standard shape. The position of pointer *F* relative to the scale on pointer *A* will indicate the amount of service metal that will remain on the tire after it has been trued. This gage will be found useful in billing foreign roads for wheel replacements.

The double-plug pipe gage referred to is illustrated at the right in Fig. 1, and is intended for measuring the taper of female threads. In using this gage, the inner plug is first screwed into the thread, after which the outer gage is screwed into place, both parts being set tight by hand. If the taper of the thread is correct, the scribed line near the top of the stem of the inner gaging member will coincide with the zero line of the graduations on the handle of the outer member, but if there should be any variation from

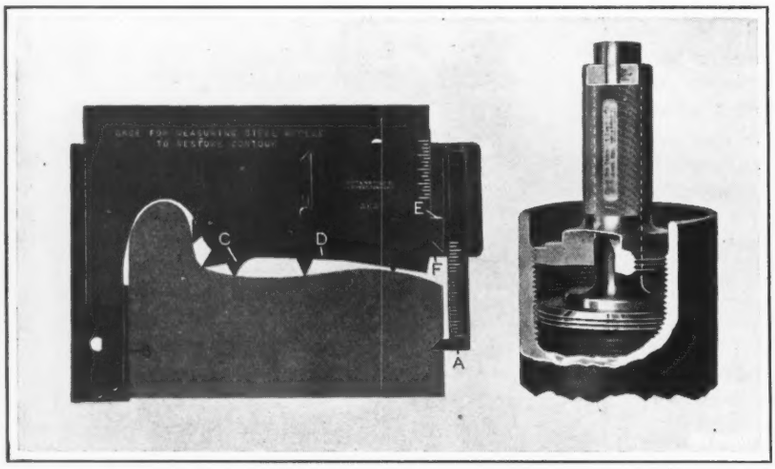



Fig. 1. Pratt & Whitney Tire Contour Gage and Double-plug Pipe-thread Gage

the true taper, this will be indicated by the position of the scribed line relative to the scale. Each division of the scale represents a variation in the pitch diameter of the thread of 0.002 inch per length of 2 inches, this being the length covered by the gage.

The adjustable limit-pin gage, illustrated in Fig. 2, has only one set of pins for taking both "Go" and "Not Go" measurements. This gage has two spherical-end hardened steel pins, which are carried in a cast-iron frame similar in construction to the frame of the Pratt & Whitney truss-form gages. One of these pins is adjustable by means of opposed set-screws which also lock it firmly in position when they are tightened. The opposite pin functions between two stops, one of which is adjustable to give any desired tolerance from 0.001 to 0.025 inch. This pin is instantly withdrawn to the "Go" position and advanced to the adjustable stop or the "Not Go" position, by a simple movement of the thumb and finger.

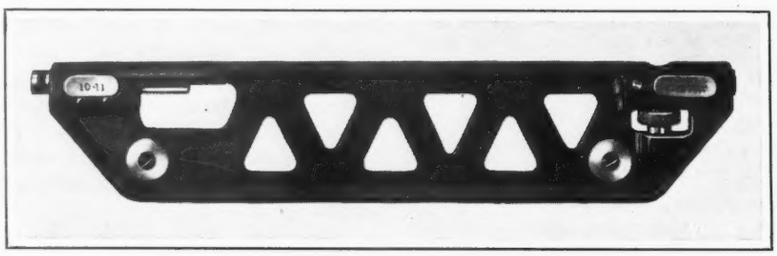


Fig. 2. Adjustable Limit-pin Gage which has Only Two Pins for Both "Go" and "Not Go" Measurements

spindle is 27 inches, and the maximum distance is 54 inches, while the minimum center distance between the extreme left-hand spindle and the adjustable spindle is 54 inches and the maximum distance 81 inches, giving a total range between spindle centers of 27 to 81 inches.

This gang drilling machine may also be arranged with but one permanently located head and one movable head. In such an installation, instead of the ways extending approximately one-half the length of the column, they could extend sufficiently to permit a minimum center distance of 27 inches between the spindles of the two heads; in other words, the ways could extend somewhat more than three-quarters the length of the column. The adjustment of the second head would then be from the position it occupies in the illustration to the extreme right-hand end of the machine.

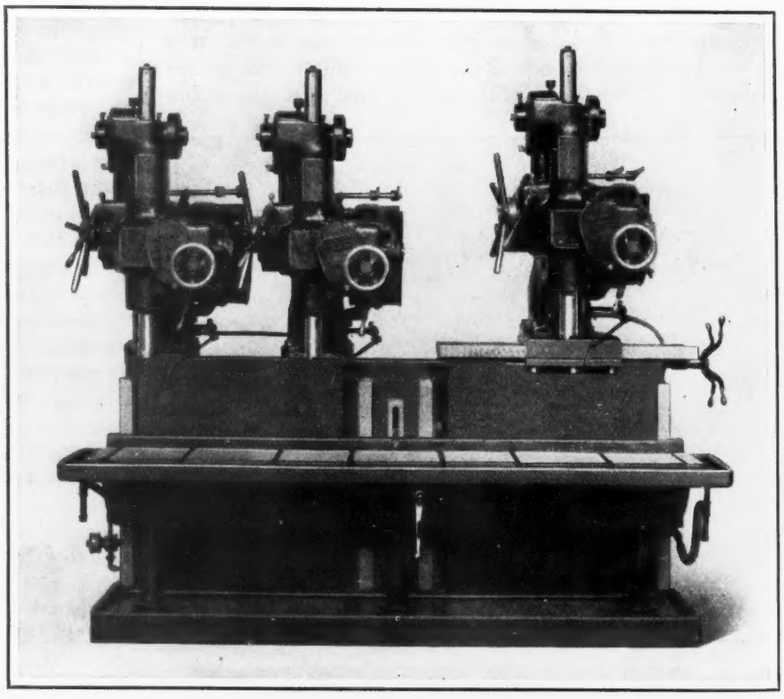
Another modification is the machine equipped with a fourth head clamped to the ways at the extreme right-hand end, the movable head being then located at its extreme left-hand position. The fourth head is similar in design to the others. This arrangement gives a four-spindle machine with a center distance of 27 inches between all spindles The fourth head may be quickly removed in order to make use of the adjustable feature of the sliding head.

The driving and feeding gears are mounted inside each head and run in oil, the gears being made from chrome-nickel steel, hardened, and heat-treated. The shafts are mounted on ball bearings and the spindles are double-splined to equalize the strain. Each spindle has a drilling capacity of two inches through solid steel. The distance from the center of the spindles to the face of the column is 12½ inches.

## COLBURN GANG DRILLING MACHINE

A gang drilling machine which may be equipped with different combinations of permanently located heads and a longitudinally movable head is being introduced to the trade by the Colburn Machine Tool Plant of the Consolidated Machine Tool Corporation of America, 1038 Ivanhoe Road, Cleveland, Ohio. The accompanying illustration shows this machine furnished with two permanently located heads at the left, which have a fixed center-to-center distance between spindles, and a third sliding head at the right. The movable head is mounted on the finished ways of a plate which extends to the extreme right-hand end of the column. Both the column and table are designed for four-spindle machines.

The sliding head has an adjustment of 27 inches on the ways by means of a screw and capstan handwheel, and may be securely clamped in any desired position along the ways. The minimum center distance between the second spindle and the adjustable



Colburn Drilling Machine equipped with One Movable and Two Permanently Located Heads

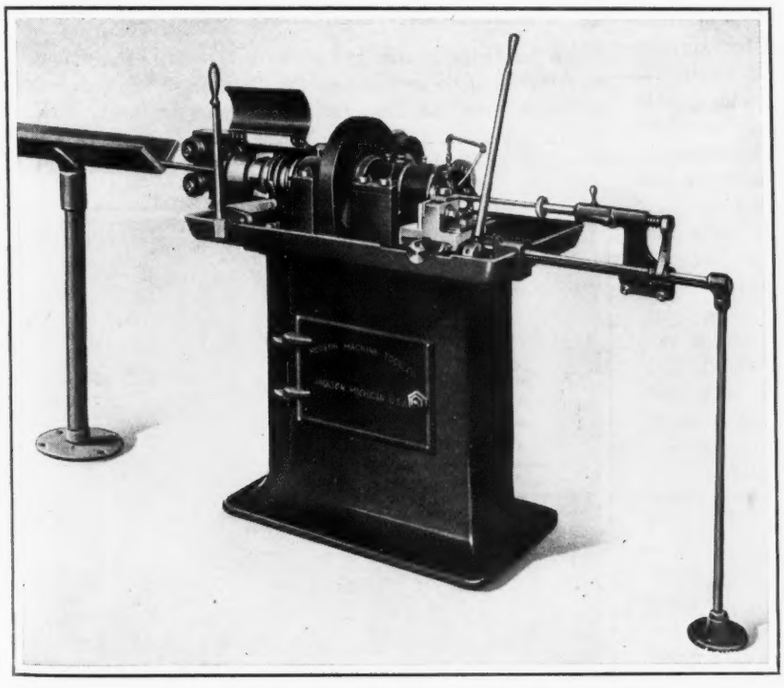
## IMPROVED CUTTING-OFF MACHINES

Three or four movements of the operator and one step on each piece of work have been eliminated by several improvements incorporated in the line of machines built by the Modern Machine Tool Co., 601 Water St., Jackson, Mich., for cutting off piping, tubing, and solid bar stock. It will be evident that with a production ranging from 150 to 600 pieces per hour, this elimination of movements effects a considerable saving. The No. 1 machine is still equipped with the roll feed that has been supplied in the past, but Nos. 2 and 3 machines have a live double roller feed.

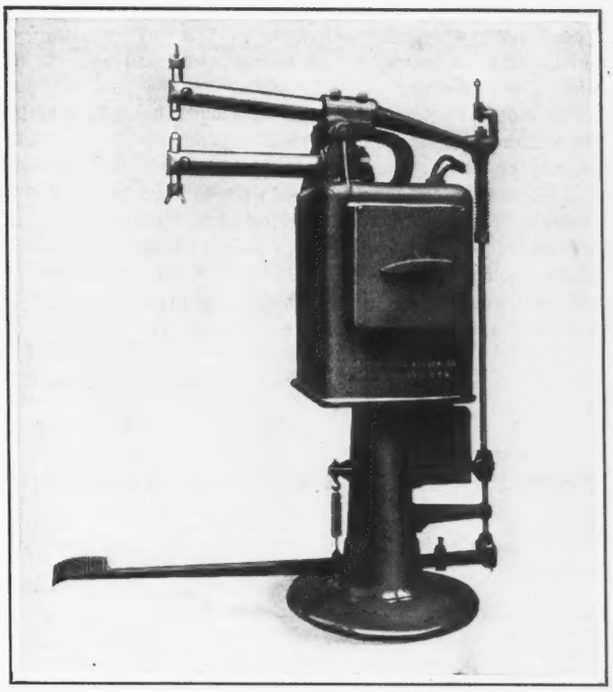
A stop, which is operated from the tool-block to automatically gage the length of the cut-off pieces, is furnished on all machines. This stop functions through a plate which is attached to the right-hand side of the tool-block, and is adjustable to take care of different sized stock. The plate is arranged with a lug that catches and rocks a block between the tool-block and the frame. During the last ⅛-inch movement of the tool-block, when the latter is withdrawn to remove the tool from the work the lug, through a lever and cam, rotates the stop to locate the stock as it is again fed. When the tool-block is advanced to start a cut, the stop is brought back clear of the work by means of a spring.

The roller feed is driven from the cone-pulley shaft through gearing. The rollers run continuously and are trunnioned and connected with the collet control-lever shaft so that an inward movement of this lever brings the rollers to the stock simultaneously with the opening of the collet. A slight further pressure is applied on this lever to feed the stock through the spindle and against the stop. The backward movement of the lever closes the collet and brings the rollers clear of the stock. This lever has been placed in a vertical position, and is said to operate more easily than on the old machines.

In the operation of the improved machine, the operator pulls the collet control-lever with his left hand to open the collet and feed the stock through the spindle to the stop; he then pushes this lever in the opposite direction to close the collet, at the same time placing his right hand on the tool-feed lever; and as soon as the collet is closed, he operates this lever to feed the tool to the work. By a reverse motion of the lever, the tool is withdrawn from the work and the automatic stop brought into place for the next piece. At no time is it necessary for the operator to remove his hands from the levers.



Cutting-off Machine built by the Modern Machine Tool Co.



U. S. Welding Machine for Light and Medium Weight Stock

## U. S. WELDING MACHINE

An electric welding machine equipped with a transformer that was described in September MACHINERY at the time it was being introduced to the trade by the U. S. Electric Welder Co., 327-328 Permanent Bldg., Cleveland, Ohio, has now been placed on the market by the same company. This equipment is intended for welding light and medium stock, which it is said to handle as readily when it is oxidized and rough as when it is smooth. The internal automatic reactance of the transformer prevents breakdowns from overload and enables the welding of stock without overheating.

The machine is furnished with an enclosed automatic switch which is equipped with a magnetic blow-out and removable contacts. A pivot switch provides different voltages at the welding points, and these members are water-cooled by means of a simple system. All mechanical parts are made of a special alloy or cast steel to give lightness without loss of strength. Extra pressure may be applied on the welding points when necessary. About four seconds is required per weld for stock 3/16 inch thick, and in welding together two sheets of bright steel, 1/16 inch thick, the production is about 4000 welds per hour. This welding machine is made in two sizes and with horns of different diameters and lengths. It can be arranged for motor drive.

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## WESTINGHOUSE SAFETY MOTOR STARTER

Complete protection to an alternating-current motor and the operator, is assured by a safety switch of simple design incorporated in a motor starter now being placed on the market by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. This starter is manufactured for motors of various capacities up to 15 horsepower. The operator of the switch is unable to touch live parts at any time because the door of the starter

is so interlocked with the switch mechanism that it can be opened only when the switch is in the "off" position, at which time all accessible parts are dead and may be inspected or renewed.

The motor is protected from overloads both in starting and running, by means of thermal cut-outs or relays. These cut-outs or relays allow reasonably high starting currents or momentary overloads which do no damage to the motor. However, when the motor is subjected to a continuous overload sufficient to overheat or damage it, the cut-outs or relays quickly open the circuit. The capacity of the starter may be readily changed by substituting proper relays. An under-voltage release coil protects the motor from failure of voltage. The entire mechanism is mounted on a slate base and can be removed without disturbing the starting box or conduits.

## HOEFER HIGH-SPEED DRILLING MACHINE

In a special ball-bearing high-speed sensitive drilling machine manufactured by the Hoefer Mfg. Co., Inc., Freeport, Ill., the spindle is automatically fed by means of a cam arrangement. The drive for the downward feed is transmitted to the cam by engaging a worm with a worm-wheel located near the top of the machine between the spindle and the column. The worm is engaged by turning the lever on the side of the column, and it is driven from the main spindle through a silent chain. The cam is made special for each job, so that the drill may be given the proper feed. At the end of the downward movement, the head is returned to its original position by springs located on the head. The head and spindle are counterbalanced.

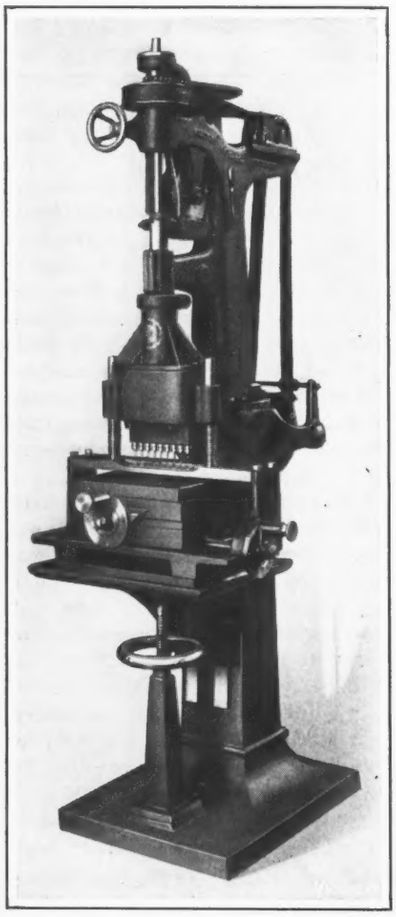


Fig. 1. Hoefer High-speed Drilling Machine with Automatic Feed

This machine is shown in Fig. 2, arranged for drilling 540 holes in a die-plate for an accounting machine. The plate is made from tool steel and is one of a series varying in thickness from ⅛ to ⅜ inch. The holes must be drilled accurately, there being a tolerance of only 0.002 inch on the center-to-center distance of the two extreme holes of a row, and of 0.0005 inch between the adjacent holes. There are twelve longitudinal rows of holes and forty-five transverse rows. The holes in the longitudinal rows have a center-to-center distance of 5/32 inch, while those in the transverse rows have a center-to-center distance of ¼ inch. The holes are too closely spaced to permit drilling all those in a row at one time, and so a drill head has been provided which has nine spindles located to drill simultaneously every fifth hole in a longitudinal row. By successively shifting the plate longitudinally a distance equal to the center-to-center distance between two adjacent holes in the row, each longitudinal row may be drilled by five downward movements of the drill head.

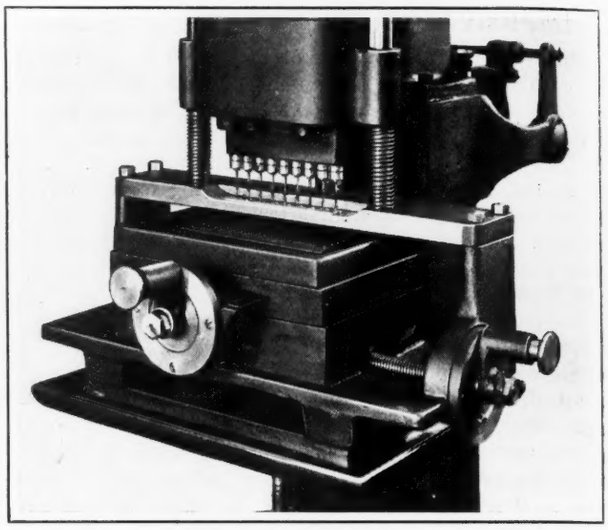
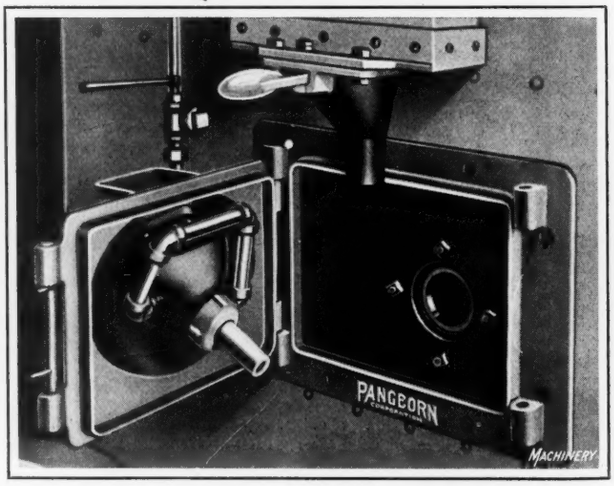


Fig. 2. Set-up for drilling 540 Closely Spaced Holes in a Tool-steel Plate

The work is located on the upper table by means of dowel-pins, so that should it be necessary to remove the plate during an operation, it could easily be replaced in its original position. This upper table is mounted on a compound table which may be accurately moved longitudinally or transversely to shift the plate beneath the drills, the thread on each adjusting screw being so cut that by turning the screw one revolution or a number of revolutions, the tables will be moved exactly the required amount. Across the top of the tables is carried a heavy steel plate in which are located slip bushings for guiding the drills during the downward movement of the head, and thus maintaining the required accuracy. Two vertical hardened and ground guide rods on this steel plate enter bearings in the head housing and keep the head and jig plate in alignment at all times. With this equipment, the plates are finished in twenty-two minutes, floor-to-floor time, whereas with the method employed before this machine was developed, from three to four hours were required for a plate.

## PANGBORN BARREL SAND BLAST

The cleaning capacity of sand-blasting equipment is governed in some respects by the distance of the nozzle from the work and the angle at which the nozzle is directed toward the work. When the class and size of work varies, it would seem that the position of the nozzle should be




Adjustable Nozzle provided on Pangborn Barrel Sand Blast

adjustable, and it is for this reason that the barrel sand blast manufactured by the Pangborn Corporation, Hagerstown, Md., which was illustrated on page 462 of January, 1921, MACHINERY, is now being equipped with a nozzle that is adjustable both horizontally and vertically to enable it to be placed in the most effective position. This nozzle is shown in the accompanying illustration.

Another improvement made in this sand blast is the provision of a mechanism which assures a constant and satisfactory separation of the abrasive so that it may be used again. The barrel drum is reinforced by plates at the door opening and by angle-irons on both the inside and outside. Steel tires are pinned to the head castings and are driven by manganese steel rollers. The driving sprockets are made of steel, and, with the chain, run in oil.

## AMERICAN BENCH BROACH PRESS

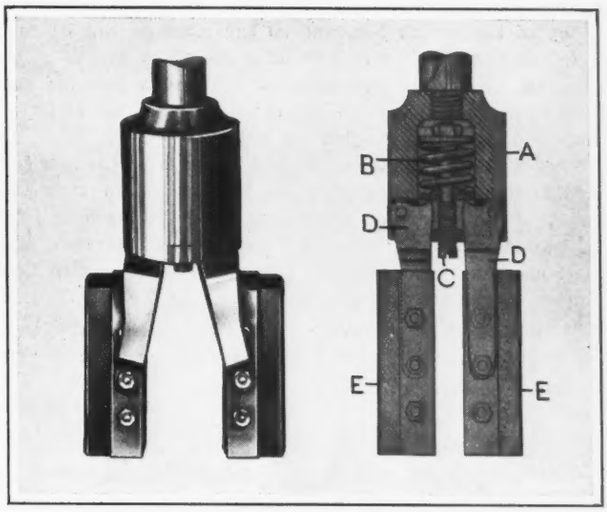
A power broach press of the bench type which has been improved in several respects over a previous design described in November, 1921, MACHINERY, has been brought out by the American Broach & Machine Co., Ann Arbor, Mich. In addition to other improvements, the machine may now be furnished mounted on a pedestal, as shown in the accompanying illustration. The new machine is provided with an automatic stop, and the movement of the ram is controlled by a positive jaw clutch made of steel and hardened. Power is transmitted to the ram through a steel worm and a bronze worm-wheel, and the return movement is accomplished by means of a counterweight. This machine can also be operated by hand through a handwheel, the latter being provided with hollow spokes to receive a leverage bar. The pedestal has an oil receptacle, as illustrated, and can be equipped with an oil pump.

American Improved Bench Broach Press mounted on Pedestal

Some of the principal specifications of this machine are as follows: Maximum stroke, 14 inches; maximum pressure developed, approximately 2 tons; maximum diameter of work that can be handled, 6 inches; diameter of hole through table, 2½ inches; and weight, approximately 315 pounds.

## STORM CYLINDER-FINISHING TOOL

A tool for polishing or burnishing automobile cylinders after reaming, reboring, or regrinding has been brought out by the Storm Mfg. Co., 406 Sixth Ave., S., Minneapolis, Minn. This tool may be used in an ordinary drilling machine or in conjunction with a special driving mechanism furnished by the manufacturer. From the illustration it will be seen that the tool consists of a body *A* to which are attached two stones *E* by means of links *D*. Held between two disks



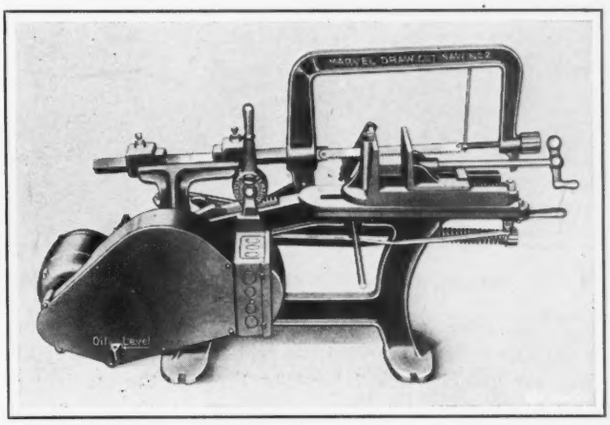

Storm Polishing or Burnishing Tool for Automobile Cylinders

in the body of the tool is a compression spring *B*, which exerts pressure on a point at the top of each link *D*, thus tending to swivel these links and expand the stones against the walls of the cylinder. The desired diameter across the stones is obtained by varying the pressure on the spring through adjusting screw *C*. There is no undue spread of the stones when the tool is not in use.

The spring pressure is normally about 110 pounds, and when the tool is centered properly in a cylinder this pressure is evenly distributed between the two stones. However, should the tool be slightly off center relative to the cylinder, the entire pressure of 110 pounds will be immediately transferred to one link, and the other link will hang free. Then, when the tool is rotated, the cylinder block will be shifted by the tool until the cylinder is central with it and the pressure is equal on both links. This feature obviates the necessity of clamping the cylinder block to a base for the operation.

## ARMSTRONG-BLUM MOTOR-DRIVEN HACKSAW

To provide a self-contained, portable equipment, the No. 2 Marvel draw-cut hacksaw manufactured by the Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill., is now made with a direct-attached motor. The motor is mounted on the rear of the machine where dirt and saw chips do not get into the operating parts. It is connected to the driving crankshaft of the machine by means of a silent chain, sprockets, and intermediate gears. These driving parts are entirely enclosed and run in oil. The motor is furnished for operation on a 110-volt lighting circuit of either alternating




Armstrong-Blum Motor-driven No. 2 "Marvel" Hacksaw

or direct current. The switch is wired to a plug receptacle on top of the switch box, and so the machine can be connected in a moment with any lamp socket by means of an extension cord. This arrangement provides a portable machine that can be taken about the shop on a small platform truck and quickly connected for use.

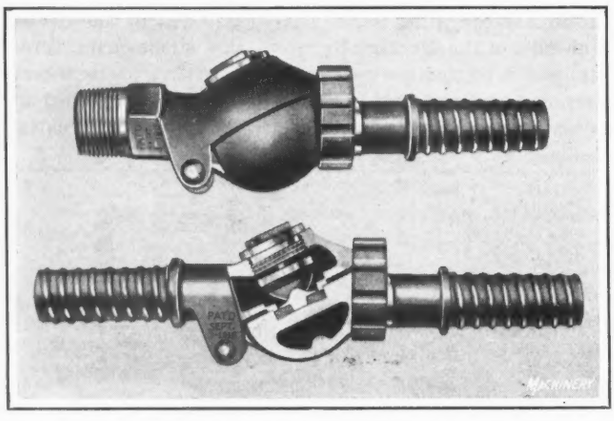
When a cut is completed, the saw frame trips the starting handle and automatically opens the switch to stop the motor. Thus the motor never runs with the machine idle, and power is saved. Millwright departments, garages, and small machine shops that are crowded for space often find it more convenient to take the machine to the job than to move the job to the machine. It is for such purposes that this portable equipment has been brought out. The hacksaw has a capacity of 6 by 6 inches on the long stroke and 8 by 8 inches on the short stroke. It receives blades of any length from 12 to 17 inches, and has an approximate weight of 350 pounds.

## ROBINSON AIR-HOSE COUPLING

The elimination of a globe valve in compressed air lines is a marked advantage of a combination valve and coupling now being manufactured by the Robinson Machine Co., 39 Eighth St., Muskegon, Mich. The illustration shows a part sectional view of the coupling for a hose and a view of the coupling for a pipe line. When an air line is equipped with this coupling, tools can be changed at the place where they are being used, without requiring the workman to walk to and from a valve at a comparatively distant point in order to shut off and turn on the air. A check valve in one of the two halves of the coupling functions automatically in this respect.

The check valve half of the coupling is so constructed that the air pressure comes on top of a brass stem which has a leather disk facing that may be easily renewed. The valve stem is centered by a reamed hole in the valve cap. Two projections with a cross-bar extend beyond the valve seat, and protect the seat when this half of the coupling is dragged along the floor at the end of a hose. The cross-bar also forms a pivot for hooking the hose shank half of the coupling in connecting the two members.

The hose shank half has two small projections beyond the valve face which push the valve open when the connection is being made and admit air pressure to that section of the line. This part of the coupling is recessed to receive a special gasket, which is cemented permanently in place. This gasket is said to have stood up under severe tests and



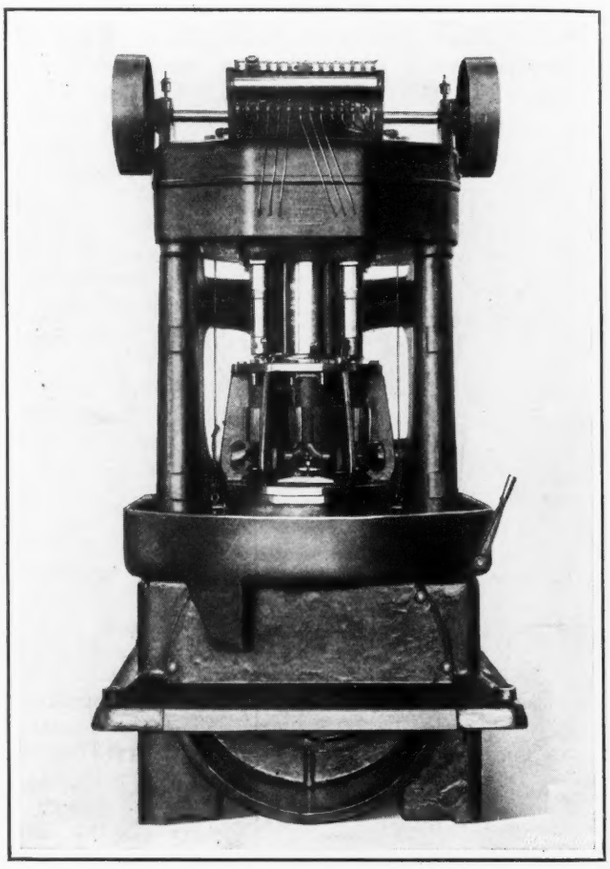
Robinson Patented Automatic Air-hose Coupling

actual operation from six months to one year without causing any trouble or requiring replacement. The coupling halves are quickly locked together through the medium of an eccentric clamping ring. The hose shank half of the coupling is furnished with a positive-grip clamp for attaching it to air lines.

## SEMI-AUTOMATIC CYLINDER BORING MACHINE

A semi-automatic vertical machine for boring air-cooled gas-engine cylinders and finishing the head of the cylinders at the end of the bore, but which may also be employed for machining cylinders cast en bloc, has been developed by the Manufacturers' Consulting Engineers, McCarthy Bldg., Syracuse, N. Y. Three separate cuts are taken in boring and two in finishing the head of the cylinder. The machine has five spindles which provide for taking all five cuts at the same time in separate cylinders. These spindles rotate but have no axial movement.

The cylinders are mounted in a rotary fixture having six positions, five working and one loading. The loading and unloading is done while the machine is in operation so that the only lost time is that required for indexing the fixture.



Semi-automatic Machine for boring Cylinders and finishing their Heads at the End of the Bore

This member is fed upward to the cutting tools by a cam which gives the fixture a quick approach to the cutting tools, a uniform boring feed, a slower feed for finishing the head of the cylinder, a dwell for the final finish of the cylinder head, and a quick return to the starting position. The cycle time of the machine for boring and finishing the head of a cylinder 3¼ inches in diameter and 9 5/32 inches long, is 1½ minutes.

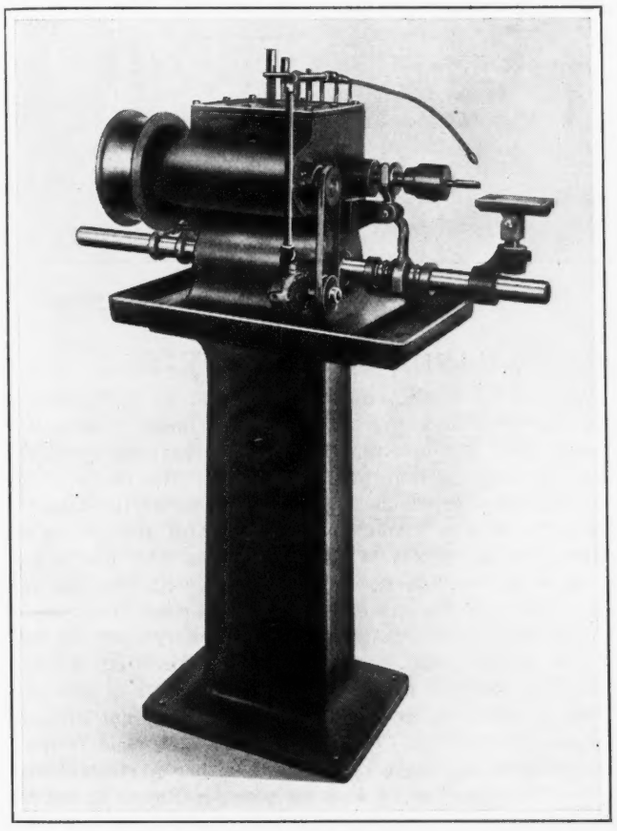
Among the features of the machine which make it possible to obtain this production rate are its general rigidity and the accurate relation held between the cutters and the rotary fixture. This relation is maintained through the use of a large-diameter pilot which is integral with the head of the machine, and by means of pilots in the ram. The latter is actuated by the cam and carries the rotary fixture. This design gives a uniform rigidity to the machine throughout its stroke.

Coolant is supplied to the cylinders to keep them at approximately a constant temperature throughout the cut so that no heat distortions occur. The coolant is pumped

through the spindles and discharged adjacent to the cutting tools on the surface to be machined. It is said that by passing the coolant through the spindles, they and their bearings are kept at a constant temperature so that the proper clearance between these members is maintained. The coolant also washes away all chips from the work. The duty of the operator consists simply of loading and unloading the work while the machine is in operation, indexing the work-holding fixture when the machine is stopped automatically at the end of the quick-return movement of this fixture, and throwing in the clutch after the fixture has been indexed.

## BURKE AUTOMATIC TAPPING MACHINE

A tapping machine equipped with a power feed and an automatic reverse so that it is not necessary to depend on the pressure on the tap to make the machine drive and reverse itself, is now being introduced to the trade by the Burke Machine Tool Co., 516 Sandusky St., Conneaut, Ohio. As the tap runs entirely free, there is no tendency for it to cut over-size or to stretch the metal. In placing work on this machine, the operator pushes it against the tap until the tap starts to enter the hole, at which time the power feed begins to drive the tap and continues to do so until the thread is completed. The spindle is then automatically reversed and the tap backed out at twice the forward speed. This arrangement relieves the operator from continually pushing the work against the tap while the latter is entering, and from pulling on the work when the tap is reversing. Thus his hands are left free to select another piece of work. These features are said to permit of higher production rates than are possible with hand-fed machines.



Burke No. 10 Tapping Machine having a Capacity for tapping Holes from ⅛ to ⅝ Inch in Diameter in Steel

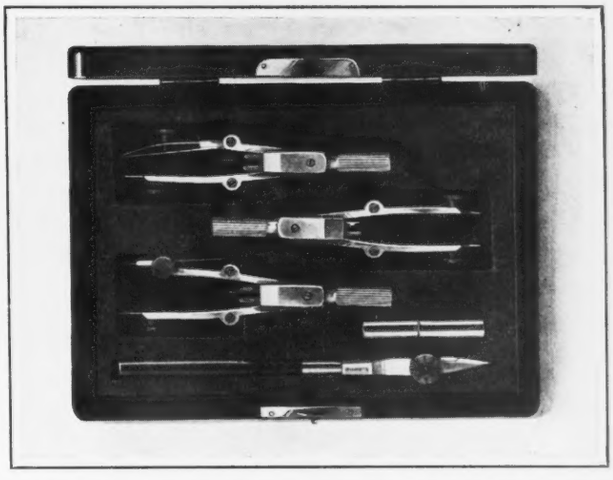
The machine is driven through a friction clutch governed by the automatic feed, which, in turn, is controlled by a second friction clutch. This design permits of setting the machine very sensitively, allows it to slip before breaking of the smaller sizes of taps occurs, and enables adjustment to insure the pulling of the larger coarse-thread taps. The machine is driven through a friction clutch not only on the forward motion, but also on the reverse motion, which does away with the breaking of taps if they should bind in backing out of the hole. The friction clutches are of the cone design, the face of the friction ring being tapered on both sides to fit into the driving and reversing cones, and the ring is keyed to the spindle.

All working parts of the machine run in oil, and the thrust of the spindle is taken on ball bearings in both the forward and reverse motions. The spindle is regularly equipped with a Skinner positive-drive chuck. The table is universal and is provided with a T-slot for attaching jigs, etc., so as to permit holes to be tapped at any angle. A face-plate is furnished to fit on the draw-bar for use in place of the table. The face of this plate opposite the front of the machine is accurately planed to suit jigs or other holding fixtures. With such a set-up the tap enters the work after passing through drilled holes in the plate, this set-up being convenient when the part to be tapped is larger than can easily be handled on the table. The plate can be set at various points along the draw-bar to accommodate different sizes of work. This machine has a capacity for tapping holes from ⅛ to ⅝ inch in diameter in steel.

## LAWRENZ DRAFTING INSTRUMENTS

A set of bow pen and pencil compasses and dividers made from an aluminum alloy, and a ruling pen having a dial nut that facilitates resetting the pen blades to draw a line of given thickness after the setting has been changed for cleaning the blades, are now being made by E. Lawrenz, 2533 McClellan Ave., Detroit, Mich., and are sold under the trade name of "Normal." The bow instruments have a sturdy construction which does not give in using them. By virtue of this construction, it is easy to draw a true unwavering circle with the pencil compass, even though the circle is being produced with heavy dot-and-dash lines.

The handle of the bow instruments is not screwed into another member, but is integral with the part to which the legs are fastened. Thus the handle cannot work loose and become lost. An extension on the handle part reaches down between the legs to guide them and make the instrument rigid. This extension has a jaw in which the knurled head of the leg-adjusting screw is retained to prevent sidewise movement. A small coil spring placed between the two legs near their upper ends takes up any play between moving parts. The gripping end of the handle is made large to permit a secure hold. These instruments are made of an aluminum alloy having a tensile strength of about 50,000 pounds per square inch. By using this alloy it is possible for the instruments to be generously proportioned and yet



"Normal" Aluminum-alloy Bow Instruments and Steel Ruling Pen

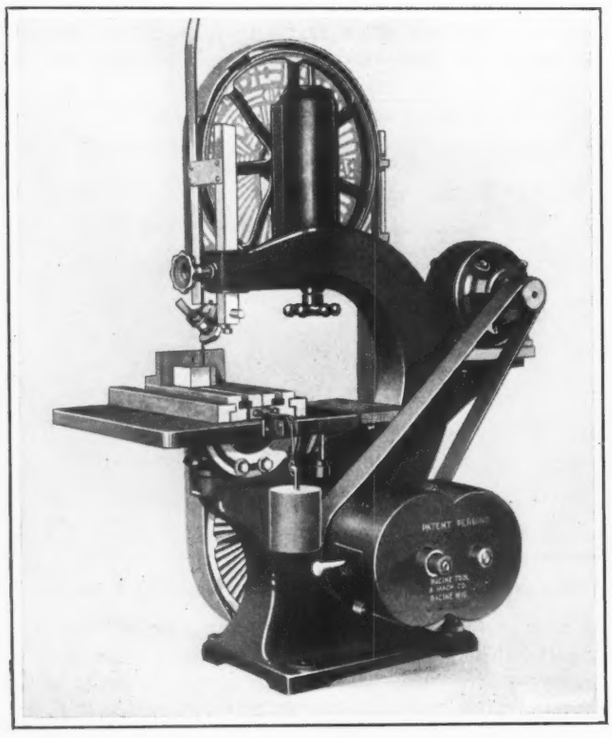
be light in weight. Another advantage of using this alloy is that the instruments do not become tarnished.

The blades of the ruling pen are made of steel and are hardened and ground separately. The ruling pen may be quickly opened for cleaning by pressing the tips of the blades together and then turning the adjusting nut and screw through 90 degrees to allow the head of the screw to slip through a slot in the rear blade. The reverse procedure is followed to close the blades.

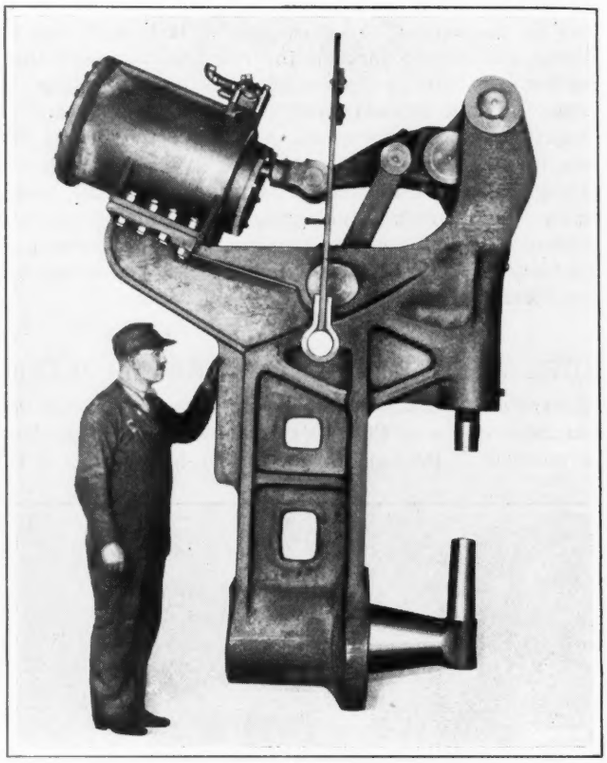
## RACINE METAL-CUTTING BAND SAW

Both metal and wood may be cut on a portable band saw of the bench type which is now being built by the Racine Tool & Machine Co., 250 15th St., Racine, Wis. It may be used for sawing steel, iron, aluminum, brass, fiber, hard rubber, etc. A two-speed attachment provides the proper speeds necessary for cutting the different materials, the change in speed being accomplished by shifting a lever. The machine is driven by a ¼-horsepower motor running at 1750 revolutions per minute, which may be connected to any electric lamp socket. The saw guide can be applied to bands for cutting metal or bands for cutting wood, and has a range of adjustment to accommodate all widths and gages of bands. The guide is quickly adjustable to any height within its range, and the table may be tilted at any angle up to 45 degrees.

The wheels are made of aluminum in order that the weight of the equipment may be reduced, and they are mounted on ball bearings. The alignment of the saw blade is accomplished by means of a hand screw, which is used to tilt the upper wheel, and the tension on the blade is controlled by a hand screw, which operates against a spring. This spring also serves as a safety device, allowing chips or blocks that may fall accidentally between the band and the wheel to pass around the wheel without breaking the band. A few specifications of this saw are as follows: Capacity under guide, with and without vise for holding metal parts, 3 and 5 inches, respectively; distance from band to throat, 14 inches; length of bands, from 7 feet 6 inches to 8 feet; and over-all height of machine, 39 inches. This equipment weighs approximately 200 pounds.



Racine Portable Band Saw designed for cutting Metal and Wood



Hanna Riveter for driving up the Last Head of Boilers through the Manhole

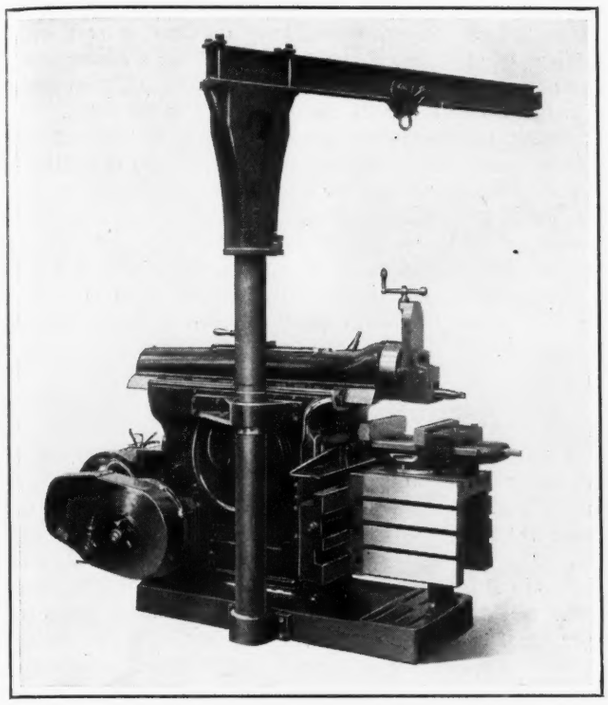
## HANNA BOILER RIVETER

For use in driving up the last head of high-pressure containers through the manhole, the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill., have designed the large riveting machine here illustrated. The rivets of the container for which the machine was primarily designed are 1¼ inches in diameter, and the plates are 1½ inches thick. The equipment is arranged for portable use in two positions and is intended for suspension with the dies vertical. The machine swivels about a point close to the center of gravity to allow swinging the stationary head on and off the forged head of the rivet in a direction approximately in the line of die travel. As a result of this construction, the mass or weight of the riveter is not lifted or lowered in riveting. The stake is an alloy-steel forging. This riveter may be arranged with either a straight-push hydraulic mechanism, or with the patented Hanna pneumatic mechanism.

The important specifications are as follows: Maximum and minimum diameters of shells which can be handled, 60 and 42 inches; reach of unit, 14 to 18 inches; distance from center of dies to the long face of the throat, 16 inches; length of gap, 35 inches; stroke of die, 5¾ inches; capacity, 100 tons; and weight, 9900 pounds.

## BARRETT-CRAVENS TRUCK PLATFORM

A lift-truck platform known as the "Steeleg" which consists of two steel legs and a wooden-plank top is being manufactured by the Barrett-Cravens Co., 1328-34 W. Monroe St., Chicago, Ill. The legs are formed from heavy gage steel and run the full length of the platform. Each is flanged at the bottom to form a foot and at the top to protect the ends of the wooden planks. The boards are 1¼ inches or 2 inches thick, depending upon the character of the parts to be handled, and are attached to the legs by means of flat-head bolts so that no projections will interfere with placing parts on the platform. Plants now equipped with wooden platforms can be supplied with the steel legs only, for substitution in place of the present skids.



Gould & Eberhardt Shaper equipped with Jib Crane for handling Heavy Work

## GOULD & EBERHARDT SHAPER JIB CRANE

For use in railroad shops, steel mills, and other industrial plants in which heavy work is handled, Gould & Eberhardt, Newark, N. J., have brought out a jib crane intended to be attached to the shapers built by this firm. This crane eliminates the necessity of using overhead cranes in placing work on the machine. The crane is attached to the shaper on the side opposite the operating side and can be revolved around a complete circle. It has an I-beam boom strong enough to carry a load of 1000 pounds at the extreme end. The mast is a piece of steel pipe, and is clamped against the frame at two points to distribute the load more equally on the machine.

The upper pintle is a steel casting, and is rigidly held in a cap attached to the mast. It has a ball and socket bearing, which insures proper alignment of the beam at all times and makes it possible to revolve the crane by the application of only a slight force. The shaper illustrated is equipped with a single-pulley drive and a selective-type gear-box, all the gears of which are made of steel, and are heat-treated and run in oil. By means of a patented double-train gear drive, which is combined with the selective-type gear drive, eight changes of speed are obtainable for every stroke, and the range of strokes is from 9 to 115 per minute. This feature makes the shaper adaptable to manufacturing purposes in plants where a considerable variety of work is done. All control levers are located for convenient manipulation from the operating position.

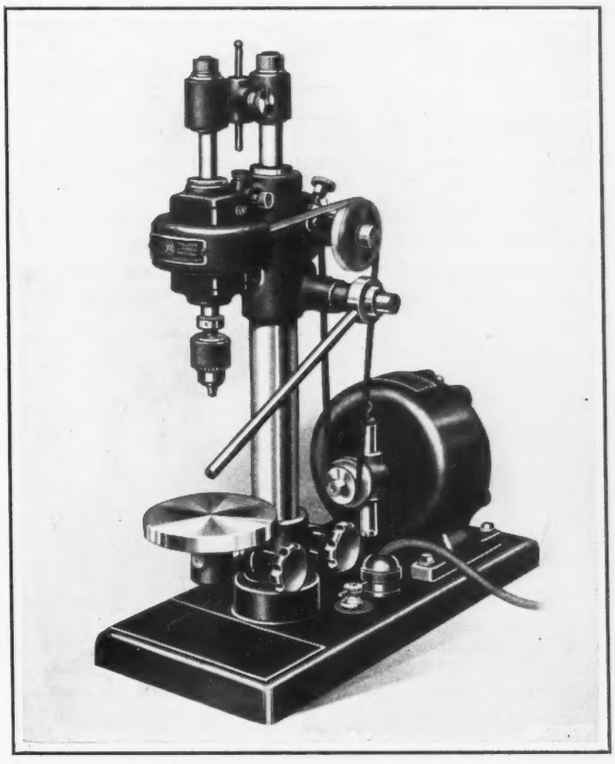
## NEW BRITAIN SEXTUPLE AUTOMATIC BAR MACHINE

In February, 1918, MACHINERY, on page 562, a 1-inch sextuple automatic bar machine built by the New Britain Machine Co., New Britain, Conn., was described. This company has now brought out a 1⅝-inch machine following the same general design as the machine previously built. Six pieces are operated upon at once, being cut off from bar stock passing through the spindles. The machine is especially adapted for cutting off pins and rolls, and for making sleeves and pipe couplings from the solid, as well as for making nut blanks, the machine having a capacity up to ⅞-inch standard nuts. The larger machine, while it follows the general design of the smaller machine previously described, embodies several improvements, including an outboard bearing for the main driving pulley, so that a ring-oiling bearing can be provided at each end of the pulley. Two pumps provide cutting lubricant; one feeds oil under high pressure through the drills, and another provides cooling lubricant to the forming tools.

## MUEHLMATT BENCH DRILLING MACHINE

A sensitive drilling machine of the bench type, which is said to have the "feel" necessary for drilling holes accurately down to 0.010 inch in diameter, and which is equipped with a chuck for holding drills up to ¼ inch, is a recent development of Adolph Muehlmatt, Lion Bldg., 5th and Elm Sts., Cincinnati, Ohio. This machine is entirely self-contained, and may be supplied from any convenient lamp socket with electric current for the motor. Although of sufficient precision for the laboratory and tool-room, it is sturdy enough for general production work. The table bracket is made in two parts, so that the table may be inclined for operations requiring an angular setting. The table may also be removed from the bracket to permit the substitution of special work-holding devices.

The spindle is fed by means of a ratchet mechanism, and the feed is controlled by convenient adjustable stops. The feeding lever may be set radially to any desired position. The spindle is equipped with a No. 1-A Jacobs chuck. The chuck spindle and the entire feeding mechanism is held in a floating condition by means of a helical spring inside the column. Ball bearings receive the thrust of the spindle, and all frictional parts of the machine are made of tool steel and hardened and ground. Normally the machine is built to give four spindle speeds of from 1200 to 2500 revolutions per minute, but speeds up to 8000 revolutions per minute can be obtained by substituting a larger motor pulley. An idler pulley at the back of the head offers a means of adjusting the belt tension. Special tables of any shape or size may be substituted for the four-inch round table with which the machine is equipped in the

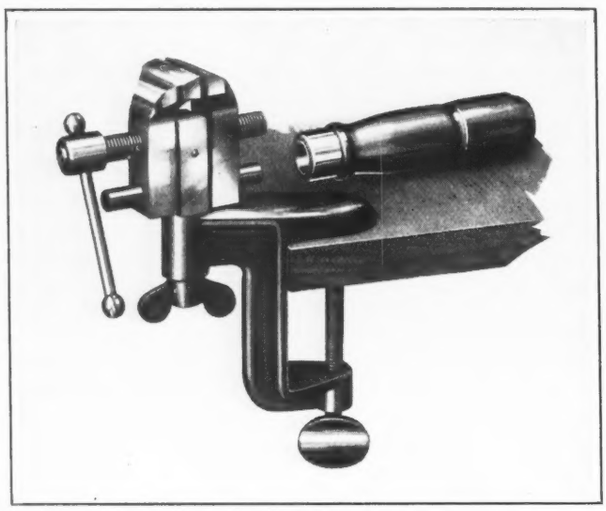


Muehlmatt Sensitive Bench Drilling Machine

illustration. Some of the principal specifications of this bench drilling machine are as follows: Dimensions of base, 16 by 7 inches; over-all height of machine, 18 inches; rating of motor, ⅛ horsepower; and weight of machine, about 50 pounds.

## STARRETT COMBINATION HAND AND BENCH VISE

A hand vise which is furnished with a clamp to permit it to be used also as a small bench vise has been brought out by the L. S. Starrett Co., Athol, Mass. This vise, which

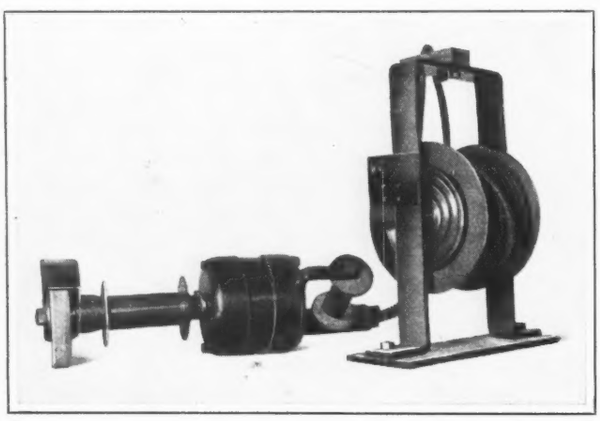


Starrett Combination Hand and Bench Vise

is designated as the No. 86, is shown in the accompanying illustration. The ball-end handle employed for tightening the jaws offers a considerable leverage. The clamp for converting the device for bench use may be fastened on shelves having a thickness of from ½ to about 2⅛ inches. This clamp is simply substituted for the handle seen lying on the bench in the illustration, and when the vise is mounted on the clamp, the jaws may be adjusted to any position about a complete circle. The jaws are tempered and polished drop-forgings, 1½ inches in width, and they have a capacity for work up to about 1½ inches wide.

## FORBES AND MYERS CABLE REEL

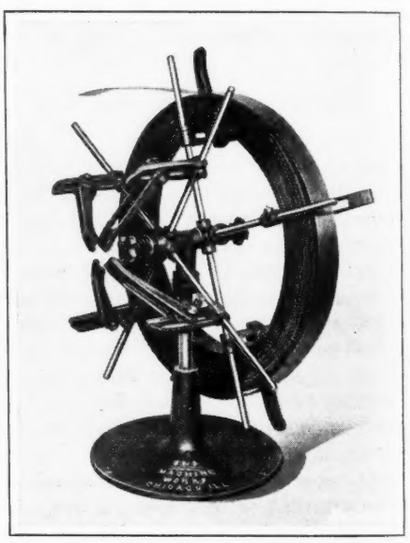
Portable electric tools usually receive current for their operation from a lamp socket to which they are attached by a flexible cord. This cord is constantly dragged over the floor as the operator moves from one position to another, is frequently stepped upon, catches on objects, and receives other treatment injurious to the cord and annoying to the operator. To avoid these difficulties, Forbes & Myers, 178 Union St., Worcester, Mass., have designed a reel which receives about 35 feet of cable. This reel has a spring strong enough to keep the cable off the floor, but not of sufficient strength to interfere with easy unreeling of the cable. This equipment considerably lengthens the life of the cable and when located centrally in a room, either on the ceiling or on a column, is sufficient for a room 60 feet square. A four-wire cable is used, three of the wires being for three-phase current, while the fourth is a ground wire which connects the frame of the portable tool to the frame of the reel. With this equipment permanently located in some part of the shop a tool is always ready for use by merely closing the switch.



Forbes & Myers Cable Reel attached to a Portable Grinder

## S & S POWER-PRESS STOCK REEL

To reduce the idle time of power presses in starting to feed a new coil of stock through the dies, the S & S Machine Works, 4522 Lexington St., Chicago, Ill., have brought out a reel which may be loaded while the machine is in operation. Two spools are mounted on a swivel-head and these spools are alternately swung into position for feeding stock to the machine, the empty spool being reloaded while the other spool is reeling out stock. The arms that retain the coil on the spools are of a quick-loading type, a feature of their construction being a snap-locking knuckle joint. The arms are bent toward the center of the reel for loading a coil, and then pushed outward to hold the coil in place.

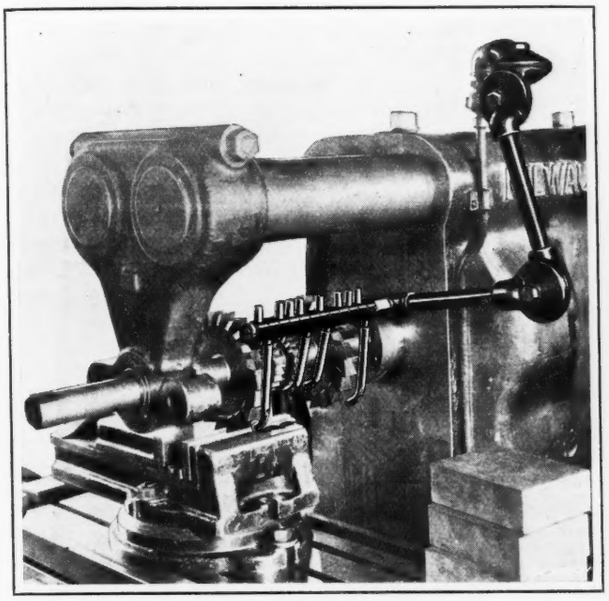


S & S Double-spool Stock Reel for Power Presses

Friction may be produced on both sides of the spool hub by means of an adjustable brake, so that any desired drag may be put on the stock. This feature is of value when the reel is used with an intermittent feed and prevents the stock from being tangled up or bent between the reel and the feeding rolls. The reel is easily adjusted to accommodate different widths of stock and core diameters, and different heights. This company also makes a reel with only one spool which can be set in any plane from the vertical to the horizontal. The reels may be furnished with or without a scrap cutter or a straightener. Reels with disks and small cores are used for such stock as copper, which is wound on small-diameter mandrels.

## BORGESON & DAVERN LUBRICATOR

For supplying cutting compound to cutters on machine tools, especially in cases where the set-up comprises multiple cutters as on screw and chucking machines, Borgeson & Davern, Inc., 501-507 E. Water St., Syracuse, N. Y., have placed on the market the "Multi-production" lubricator with which the milling machine here illustrated is equipped. This lubricator has a slotted distributing tube which is attached to one of the swinging arms of the lubricator by screwing into a threaded plug. Mounted on this tube are a number of nozzles which may be readily adjusted to open or closed positions, and when in the open position, are provided with spouts for delivering the compound directly to



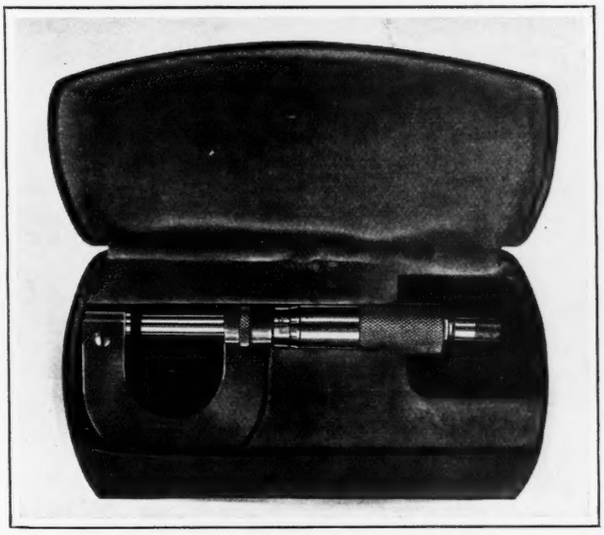
Milling Machine equipped with the Borgeson & Davern Lubricator

the cutting edges of the tools. The spouts vary in length to suit circumstances, and the nozzles are held in the set position by spring tension. The thread on the attachment plug is made special to suit Jones & Lamson machines.

The compound is delivered from the distributing tube to the nozzles through elongated slots which register with holes in the nozzles when the latter are in the open position. These slots are comparatively long to allow a considerable range of nozzle adjustment in the open position. The swivel joints of this lubricator may be either single or double to allow the distributing tube to be located in any desired position relative to the work. The frictional surfaces of the joints are ground to prevent leaking. This lubricator is made in three styles.

## BROWN & SHARPE MICROMETER CASES

Two styles of pocket cases for protecting micrometers from dirt and injury are being placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. These cases are designed to hold the "Rex" 1-inch micrometers and the regular type made by the company. They are made of metal, leather-covered, and are plush-lined. These cases are of a shape that adapts itself to the pocket without causing the pocket to become bulged.



Pocket Case for Brown & Sharpe 1-inch Micrometers

## A CORRECTION

In April MACHINERY an article was published referring to a proposed merger of machine tool manufacturers, and in the list the Lodge & Shipley Machine Tool Co. of Cincinnati was included. Before the MACHINERY form containing this article went to press, we received a telegram from Mr. J. Wallace Carrel, vice-president and general manager of the Lodge & Shipley Machine Tool Co., requesting us to make no statement of the merger as then proposed, because it had not been consummated and probably would not be. That request should have been complied with, as his company did not join the combination, and it was an error on our part to include the name of the Lodge & Shipley Machine Tool Co. in our article.

* * *

## NEW MACHINERY AND TOOLS NOTES

**Circular Slide-rule for Metallurgists:** Pittsburg Electric Furnace Corporation, Union Bank Bldg., Pittsburg, Pa. A circular slide-rule known as the "Lectromelt calculator" which lessens the computations of furnace superintendents, melters and metallurgists in the steel-making industry. This device is useful in calculating the amount of various alloys to be added to a furnace charge for obtaining the desired mixture of metal.

**Foot and Power Punch Press:** A. F. Way Co., Hartford, Conn. A small press with a stroke of one inch. By simply changing a bolt, the press can be operated either by foot or by power. As a foot-press, it is operated by a swinging foot-lever or pendulum which actuates the clutch mechanism, and when arranged for operation by power, the pendulum becomes a trip-lever and the machine is then actuated through an eccentric and toggle levers at the rear.

**Bench Drilling Machines:** Sigourney Tool Co., Hartford, Conn. Several bench and column drilling machines which may have a single-, two-, three-, or four-spindle head. On one machine the spindle is equipped with ball bearings for operation at high speeds, the maximum speed being normally 8000 revolutions per minute, although considerably higher speeds may be employed. Another type intended for operation at slower speeds is provided with plain spindle bearings except for a ball thrust bearing which takes the pressure on the spindle.

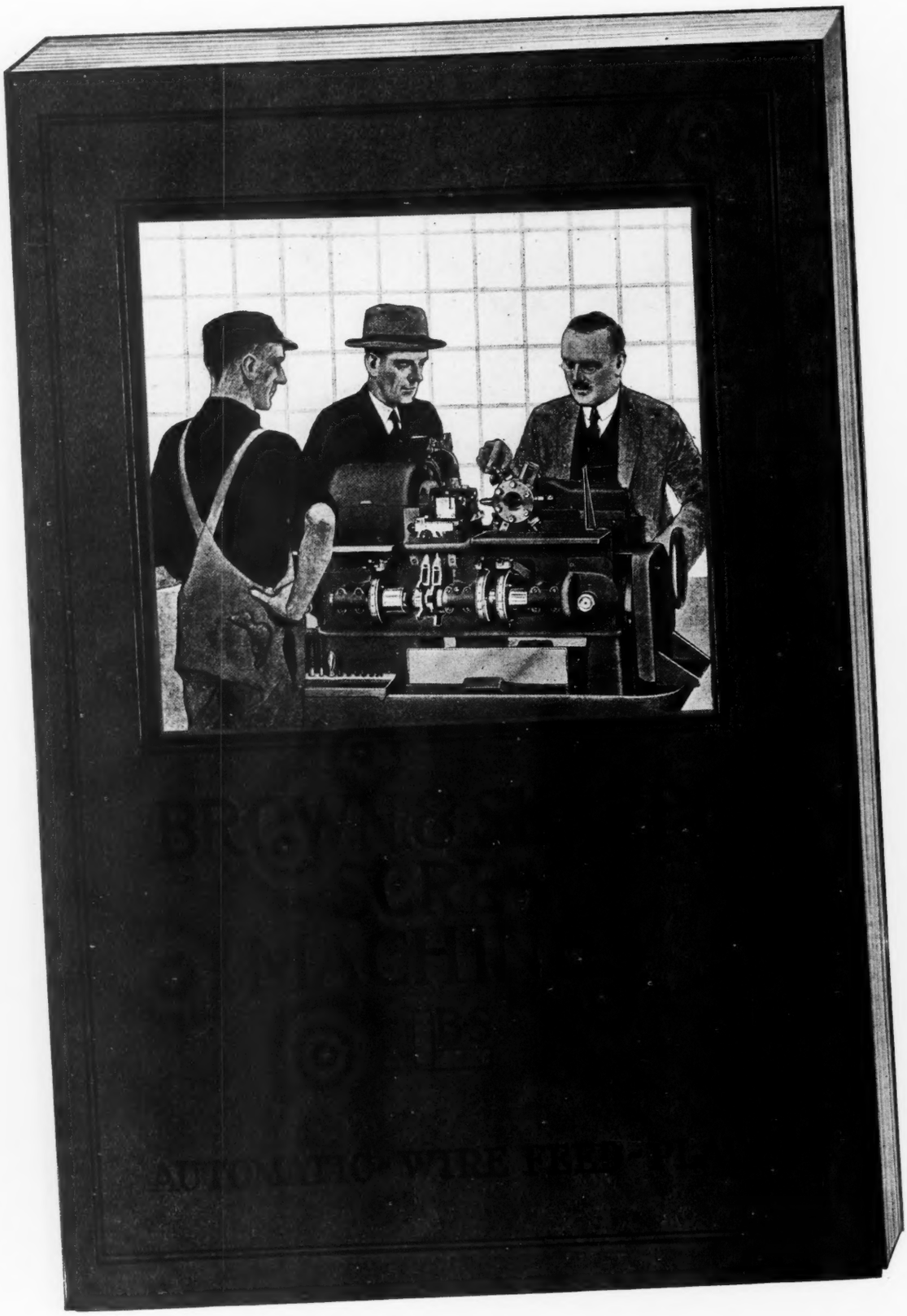
**Bolt and Cap-screw Shaving Machine:** Asa S. Cook Co., Hartford, Conn. An improved machine for shaving the heads of bolts and cap-screws. One tool faces the shoulder under the head of the bolt or cap-screw while another rounds or otherwise forms the end of the head. The tool-carriers swing about axes set at a slight angle to the center line of the machine, so that as the tools advance to the work, they are drawn slightly nearer together. By this movement the tools are cleared immediately upon finishing the cut and withdrawn without dragging.

**Spring Chuck:** Rockford Milling Machine Co., Rockford, Ill. A spring chuck or collet-holder for small rods, straight-shank drills, milling cutters, etc., in which the spring collet is held securely in place by means of a worm-wheel threaded on the inside to fit threads on the end of the collet. The worm is turned toward the right by means of a key wrench in order to draw in the collet, this member being drawn against a taper seat which closes the nose centrally without producing side strains. The collet is forced out by turning the key wrench to the left.

* * *

### EGYPTIAN ENGINEERING STUDENTS IN AMERICAN SHOPS

Ten Egyptian students, graduates of the engineering schools of Egypt, have been sent to America by the Egyptian Government to learn American manufacturing methods. These men have been placed by the Department of Commerce in automobile and other factories, where they will work as employes for two years with the purpose of acquiring a knowledge of American methods and machine shop equipment. The Egyptian Government pays all the expenses of these students. Some will study the subject of interchangeable manufacturing, and others railroad transportation, telephone systems, marine engineering, and Diesel and internal combustion engine construction. It is expected that when these students return to their native country they will introduce American methods, which will increase the demand for American machine tools and shop equipment.



# —JUST OUT

## 200 Pages of Screw Machine Facts

This New Edition of our Screw Machine Catalog describes our complete line of Automatic, Wire Feed and Plain Screw Machines, Attachments and Tools.

***Ask for No. 23-G.***

**Write Today.**

## BROWN & SHARPE MFG. CO.

**Providence, R.I., U.S.A.**

## WAGES IN GERMAN INDUSTRIES

An agreement was made in September between the employers and the employes in the German machine industries in regard to wages. This agreement was in effect from September 25 to October 29. Now it has become the practice to make new wage agreements every two weeks, because this is the only way in which wages can be maintained in a fair proportion to the falling value of the mark. To mention the amount of wages in marks per hour, means comparatively little to American readers, yet it may be of interest to know that early in November the wage rates in force for workers over twenty-one years of age varied from 70 to 120 marks per hour. For workers from eighteen to twenty-one years of age, wages early in November varied from 61 to 102 marks per hour. Workers from fourteen to eighteen years of age earned from 40 to 58 marks per hour. On November 19 all these wage rates were increased approximately 10 per cent.

The best idea of what these wages mean is obtained by measuring them by their purchasing power. The average hourly wage of a worker over twenty-one years of age will purchase one pound of bread or one quart of milk. Four hours' wages are required to purchase a pound of beef, and twelve hours' wages will buy a pound of butter. It takes forty hours to earn a 25-pound bag of flour.

On the other hand, in proportion to selling prices, employers say these wages are high. The general manager of a large machine tool concern stated early in November that the wages and costs of materials are too high for profitable operation of the plants, and that if present conditions continue, some of the shops will have to go into bankruptcy. While there are fewer strikes for higher wages at present, the efficiency and the willingness on the part of the workers to do hard work has greatly decreased. For example, it is stated that the Krupp Works in Essen are getting only 46 per cent of the output that they should, and the Phoenix Works give 45 per cent as the figure of the productive capacity obtained in their works in pig iron production. The steel output is only 60 per cent, as compared with 1913. The true rulers of Germany, it is said by many, are the labor unions, and the German Government is only their mouthpiece.

The machine-building industries in general book comparatively few new orders. The locomotive shops have relatively little to do, and an order from Roumania recently received for fifty new locomotives was, therefore, considered a great help. The production costs in the shipbuilding industries have increased so much that the steamship companies are not ordering new ships. The well-known Siemens concern celebrated its seventy-fifth anniversary this fall. In August of this year this company employed over 96,800 men.

Reports of large dividends paid by German concerns expressed in per cent are very misleading. One German machine tool builder, for example, paid a 30 per cent dividend last year, the net profits running into hundreds of thousands of marks. When converted into dollars, however, the total net profits of the concern for the year were less than $200. Another large machine tool builder paid a 25 per cent dividend and 250 marks extra per share; but the total net profit was less than $700 and the 250 marks per share amounts to only a few cents.

The prices of machine tools change so rapidly that they are of interest only as a record of the financial conditions that Germany is passing through. The price of a punch press, weighing 4000 pounds, was 750,000 marks (approximately $125) early in November.

* * *

During the past fiscal year the Bureau of Foreign and Domestic Commerce answered 589,533 inquiries relating to foreign trade and tariffs, foreign commercial law, and other subjects which come within the scope of the Bureau.

## PERSONALS

W. W. SAYERS of the Link-Belt Co., Chicago, Ill., has been promoted to the position of chief engineer of the company's Philadelphia works and eastern operations. For many years Mr. Sayers represented the company in the Chicago territory. His headquarters will be in Philadelphia.

R. H. BECKER, formerly connected with the machine tool building and sales department of Joseph T. Ryerson & Son, is now with the Milwaukee Machinery Co., 93 W. Water St., Milwaukee, Wis. He will have charge of machine tool sales in part of the Milwaukee and southern Wisconsin territory.

OGDEN R. ADAMS, Rochester, N. Y., who for the last eighteen months has been associated with the Seneca Falls Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y., in the capacity of president and general manager, resigned November 1. Mr. Adams will hereafter devote his entire time to his business interests in Rochester, Buffalo, and Syracuse.

JOHN H. PECKHAM, who has been connected with the Norton Co., Worcester, Mass., for many years as a grinding machine specialist, is now associated with Henry Prentiss & Co., 149 Broadway, New York City, in the same capacity. Mr. Peckham will cover the entire territory of the company in an endeavor to give better grinding machine service to its customers.

FREDERICK FRANZ, who, for the last four years was chief engineer of the Terminal Engineering Co., manufacturer of a truck designed for combined indoor and outdoor service in connection with railroads, shipping and industrial plants, has established an engineering office at 27 Warren St., New York City, for the purpose of solving special problems of engineering relating to labor-saving machinery for industrial plants.

C. E. SKINNER, assistant director of engineering of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., is now in Europe attending the meeting of the Rating Committee of the International Electro-Technical Commission in Geneva, Switzerland. A large delegation from the United States, and delegations from most of the European countries interested in the manufacture of electrical machinery are in attendance.

FRANK W. WIRFS, until recently sales manager of the Power Equipment Co. of Minneapolis, Minn., has joined the sales organization of the Chicago Belting Co., 127 N. Green St., Chicago, Ill. He will be located in Minneapolis and will cover the surrounding territory. Mr. Wirfs spent the first five years after he left the University of Washington, running his own sawmills in Oregon. Later he was salesman for a year and a half for the A. H. Averil Co. at Portland, Ore., jobbers of sawmill and threshing machinery, and more recently sales manager of the Power Equipment Co.

PAUL M. LINCOLN has been appointed director of the School of Electrical Engineering in the College of Engineering, Cornell University, to succeed Professor Alexander Gray, who recently died. Mr. Lincoln graduated from the Ohio State University in 1892, and has since been connected with the Westinghouse Electric & Mfg. Co., and the Niagara Falls Power Co. In 1919 he became connected with the Lincoln Electric Co., which was organized by his older brother in 1894. He thus brings to his position as director of the School of Electrical Engineering a practical engineering experience of nearly thirty years.

BENJAMIN G. LAMME, chief engineer of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been awarded the Joseph Sullivant medal by the Ohio State University. Mr. Lamme, who was graduated from the Ohio State University in 1888, is the first person to receive the medal; in the future it will be awarded once every five years for an "admittedly notable achievement on the part of a son or daughter of the university." In June, 1919, the Edison medal was awarded to Mr. Lamme by the American Institute of Electrical Engineers for the solution of special problems and developments in electrical machinery.

* * *

The Committee of Science and the Arts of the Franklin Institute, at a recent meeting, awarded the Edward Longstreth medal to the Noiseless Typewriter Co. of New York "in consideration of the ingenuity shown by the inventors, the excellence of design and construction as exhibited in the machine, resulting in a thoroughly commercial noiseless typewriter"; and also to Edward J. Brandt of Watertown, Wis., "in consideration of the ingenuity shown in the design of the automatic cashier, the excellence of its construction, and its successful use in money-changing operations."

It is easier on this job for F. X. Madlener of the Dexter Folder Company, Pearl River, New York, to operate the Cincinnati No. 4 Vertical Miller from the rear instead of from the front of the machine.

# Double Control
**(Complete)**

**A VALUABLE FEATURE found on**

# CINCINNATI No. 4 & No. 5 Millers

Facility of observation determines the operator's choice of position on all Cincinnati No. 4 and No. 5 High Power Millers. A duplicate set of levers gives complete independent control of all feeds from the rear as well as from the usual position in front of the table.

***There are other important features. Our catalog tells about them. Write.***

## Our Products

Plain and Universal Milling Machines including Cone and Single Pulley Types
(Five Sizes)

Vertical Milling Machines
(Four Sizes)

Automatic Manufacturing Milling Machines
(Six Sizes)

Universal Cutter and Tool Grinder

Complete line of Milling Attachments
(In all, thirty-eight (38) Types and Sizes of Milling Machines)

*Write us for any or all of the following books*

General Catalog—Cincinnati Millers
Catalogs No. 4 and No. 5—Cincinnati Millers
Catalog-M Type—Cincinnati Millers
Catalog—(Treatise)—No. 1½ Cutter and Tool Grinder
Tool Room Methods
Locomotive Repairs
Autobiography of an Arbor
Treatise on Milling and Milling Machines ($1.50)
Industrial Medicine in a Labor Policy

# The Cincinnati Milling Machine Company
**CINCINNATI** **OHIO, U. S. A.**

## TRADE NOTES

REED-PRENTICE Co., 677 Cambridge St., Worcester, Mass., announces that the Detroit office of the company has been removed from 642 Beaubien St., to 6526 Cass Ave.

E. L. ESSLEY MACHINERY Co., 551 Washington Blvd., Chicago, Ill., has moved its Milwaukee branch into more spacious quarters at 78 W. Water St., Milwaukee, Wis., where a large number of new and used machine tools will be displayed.

WHITING CORPORATION, Harvey, Ill., manufacturer of cranes, foundry equipment, and railway specialties, has appointed C. F. Bulotti Machinery Co., 67 Main St., San Francisco, Cal., agent for the state of California, to succeed the Eccles & Smith Co., of the same city.

MONITOR CONTROLLER Co., Baltimore, Md., manufacturer of the "Just Press a Button" system of automatic control for motor-driven apparatus, has recently established a southern branch office at Birmingham, Ala. Other branch offices are located in a number of the larger cities.

PYRENE MFG. Co., 520 Belmont Ave., Newark, N. J., announces that, on account of the fact that it has been very successful in using the Parker process for preventing rusting of steel on fire extinguisher brackets, the company has now enlarged its plant in order to handle work for other manufacturers.

HERBERTS MACHINERY & SUPPLY Co., 3rd and San Pedro Sts., Los Angeles, Cal., has been appointed exclusive representative by the DIAMANT TOOL & MFG. Co., Inc., 95 Runyon St., Newark, N. J., in connection with the sale of Diamant standard punch and die sets, in the territory covered by the entire states of California, Arizona, and Nevada.

NORWALK IRON WORKS Co., South Norwalk, Conn., builder of air and gas compressors and refrigerating machinery, has opened a Chicago office at 627 W. Washington Blvd., in charge of L. R. Bremser, who for thirteen years was associated with the Gardner Governor Co., and who is thoroughly familiar with all the phases of the compressor business.

FIRTH-STERLING STEEL Co., McKeesport, Pa., has added to its line the Globe polished drill rods drawn by the Globe Wire Co., of Sharpsburg, Pa. These rods are made from steel produced by the Firth-Sterling Steel Co. Complete stocks of Globe drill rods are now carried in the Firth-Sterling Steel Co.'s New York, Boston, and Philadelphia warehouses.

CLEVELAND TWIST DRILL Co., Cleveland, Ohio, announces that E. G. Buckwell retired from his position as secretary and sales manager on November 1, after more than twenty-three years of service. Mr. Buckwell retains his interest in the company, and will remain a director. He will be succeeded as sales manager by W. E. Caldwell, formerly assistant sales manager, who has twenty-one years' experience in the company's sales department.

GIBB INSTRUMENT Co., Detroit, Mich., manufacturer of electric welding equipment, announces the removal of its plant and offices to Bay City, Mich., effective December 1. The purpose of this change is to provide greatly increased manufacturing facilities to take care of the company's rapidly increasing business. For the last two years this company has concentrated on the development of automatic and semi-automatic arc, spot, and seam welders.

WESTERN SCREW-PRODUCTS Co., St. Louis, Mo., whose plant was recently destroyed by fire, has obtained a new permanent location at Main and St. George Sts., St. Louis, and is now again in production. The capacity range of the new plant will be larger than formerly, the new shop being equipped to handle screw machine work up to and including 2¾ inches in diameter. Plain and castle nuts are also manufactured, and special work done to order.

VICTOR TOOL Co., INC., Madison & W. M. R. R., Waynesboro, Pa., has appointed Edward T. Oliver representative in northern Ohio for the company's entire line of self-opening die-heads, collapsible taps, nut facing machines, and floating reamer-holders. Mr. Oliver's headquarters will be at 2031 Lincoln Ave., Lakewood, Cleveland, Ohio. The company has also appointed the J. F. Burh Machine Tool Co., 7762 Dubois St., Detroit, Mich., representative for its entire line in eastern Michigan.

STREET BROS. MACHINE WORKS, Chattanooga, Tenn., manufacturers of hoisting equipment, have been consolidated with the PATTEN MFG. Co., Chattanooga, Tenn., also a manufacturer of hoisting machinery. The products of the two companies will henceforth be manufactured and marketed by STREET BROS. MACHINE WORKS, INC., and will include the Street line of large hoisting equipment, together with the small and medium-sized Patten hoists. J. H. Street will continue as president of the consolidated company, and J. W. Burress, sales manager of the Patten Mfg. Co., will be sales manager of the consolidated company.

ROCKFORD MILLING MACHINE Co., Rockford, Ill., has made the following changes in agencies: J. C. Austerberry, of Detroit, Mich., will sell Rockford milling machines in that territory; the Cooperative Machinery Co. of Cleveland, Ohio, has been appointed exclusive dealer for the Rockford Milling Machine Co. and the Rockford Tool Co., in the Cleveland territory; and the Western Iron Stores Co., Milwaukee, Wis., has been made exclusive representative for the Rockford Milling Machine Co. and the Rockford Tool Co. in the state of Wisconsin.

DOLMAN MFG. Co., Springfield, Mass., has been formed by Guy W. Donahue, formerly president and sales manager of the Victor Saw Works, Inc., Middletown, N. Y.; William F. Pollock, formerly president of the Napier Saw Works, Middletown, N. Y., and for many years, general manager of the Victor Saw Works; and Chester C. Jackman, formerly factory manager of the Victor Saw Works. The new company will engage in the manufacture of high-grade tools. The first of these, known as the Dolman screwdriver, is already on the market.

RELIANCE GAUGE COLUMN Co., 6008 Carnegie Ave., Cleveland, Ohio, announces that the "Cleveland" clutch business has been sold to the WESTERN ENGINEERING & MFG. Co., 360 E. Grand Ave., Chicago, Ill., which has been incorporated as a subsidiary of the Western Valve Bag Co. for the purpose of taking over the manufacture and marketing of this clutch. The increased demand for the steam specialty line made by the Reliance Gauge Column Co. and the development of a new method float caused the company to dispose of this end of its business.

ALVORD REAMER & TOOL Co., Millersburg, Pa., manufacturer of reamers, milling cutters, twist drills, punches and dies, chisel blanks, special tools and drop-forgings, has started a service department in connection with its engineering department under the direction of A. M. Lindsley, chief engineer. This service department will give consulting engineering advice in connection with special tool equipment. Paul A. Cuenot has been appointed representative to furnish special tool service to customers. Mr. Cuenot was formerly connected with the American Locomotive Co. and the Pennsylvania Steel Co.

CONSOLIDATED TOOL WORKS, INC., 296 Broadway, New York City, is now represented in New York City by William H. Thompson, formerly with the Union Hardware Co., Torrington, Conn. Howard A. Postley, formerly with the Knickerbocker Mfg. Co., Belleville, N. J., represents the company in the New England states. William L. Rubin, formerly with the Jacobs Scale Co., New York City, represents the company in New York, Pennsylvania, Maryland, District of Columbia, and parts of West Virginia and Ohio. Charles Alburtus, formerly with the American Safety Razor Co., Brooklyn, N. Y., represents the company in New Jersey.

* * *

## RELATIVE DURABILITY OF DIFFERENT KINDS OF WOODS

In response to many requests for information on the relative durability or resistance to decay of untreated woods, the United States Forest Products Laboratory at Madison, Wis., has prepared a table based on such records and information as are available on this subject. Taking the durability of commercial white oak as 100 per cent, this table shows that black locust and osage orange are the most durable of woods, the former being from 150 to 250 per cent, and the latter from 200 to 300 per cent. Among other woods that are more durable than white oak are eastern red cedar juniper and other species of cedar except white southern; cypress; redwood; Pacific yew; catalpa; chestnut; red mulberry; and black walnut. Of the fifty native kinds of woods listed all the others are equal to or less durable than white oak. Hemlock, fir (except Douglas fir), and pine (except southern yellow pine) are among the least durable of the native woods.

* * *

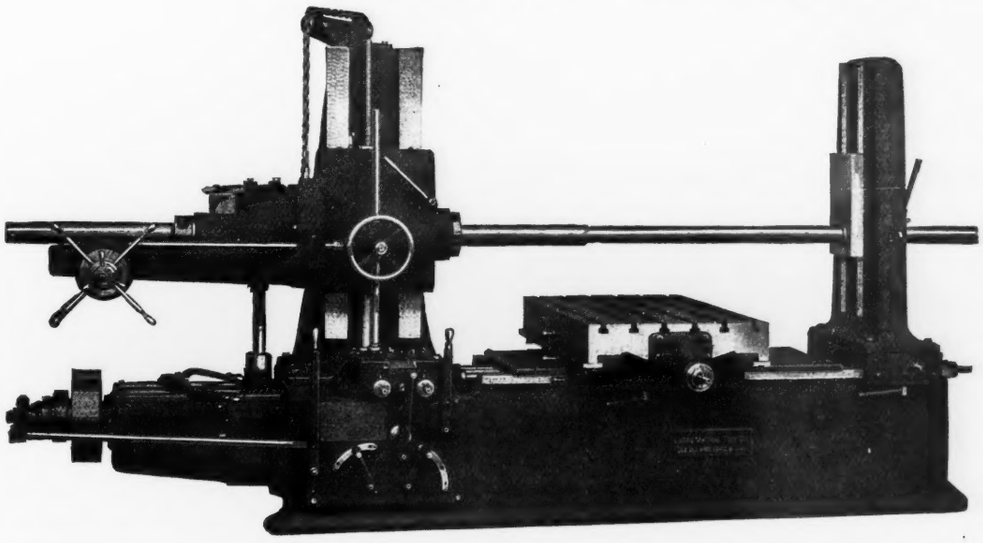
## NEW FORM OF INVOICE FOR AUSTRALIA

The Department of Trade and Customs of Australia announces through its office at 44 Whitehall St., New York City, that a new form of invoice and certificate has been adopted to be effective January 1, 1923, but the new form will be accepted for goods arriving before that date. A copy of the form may be obtained by communicating with the Australian Department of Trade and Customs at the address given in the foregoing.

*"Art stays the relentless hand of time"*

# The "PRECISION"

## Boring, Drilling and MILLING MACHINE



Makes a good OLD Machine

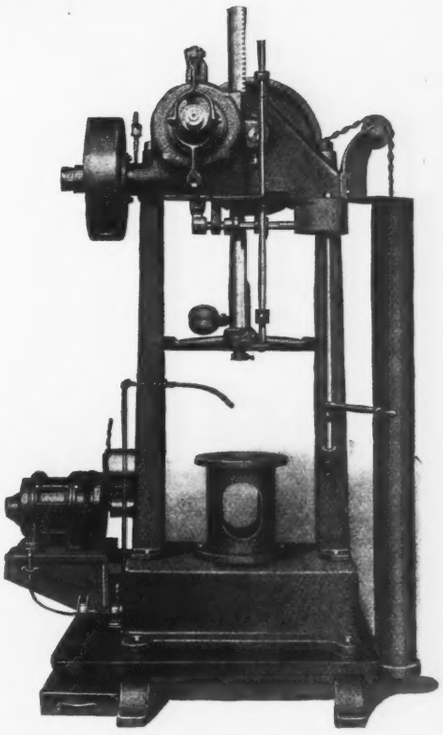
Almost like SLEIGHT OF HAND is the ease and quickness with which our new

## Vertical Push-Broaching Machine

handles the broach.

"A SIMPLE TWIST OF THE WRIST" DOES THE TRICK

*Less floor space—More production*



**LUCAS MACHINE TOOL CO.** NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo, Japan.

## NATIONAL FOUNDERS' ASSOCIATION CONVENTION

The National Founders' Association held its twenty-sixth annual convention at the Hotel Astor, New York City, November 22 and 23. Among the important addresses presented before the convention was the annual report of William H. Barr, president of the association, which called attention to the duty of employers in industrial relationships, and showed clearly that under present conditions there is no definite solution of the labor problem. The other addresses presented were as follows: "The Railroad Situation," by L. F. Loree, president of the Delaware and Hudson Railroad; "The Open Shop," by John E. Edgerton, president of the National Association of Manufacturers; "The Proposal to Destroy the Judicial Power," by James A. Emery, counsel for the National Founders' Association; "The Physician in Industry," by Dr. J. J. Moorhead, New York; "Improved Foundry Practice," by D. R. Wilson, vice-president of the Wilson Foundry & Machine Co., Pontiac, Mich.; and "Apprenticeship," by William M. Taylor, Chandler & Taylor Co., Indianapolis, Ind.

* * *

An important step toward the elimination of the differences between specifications for government purchases and commercial practice has been taken through the appointment, by the American Engineering Standards Committee, of a standing Committee on Cooperation with the Federal Specifications Board. Work carried out under the general direction of this committee will give industry a better opportunity to participate in the development of specifications for government purchases, and it will at the same time bring to the government, to a greater degree than has heretofore been possible, the assistance of the industrial organizations cooperating in the work of the American Engineering Standards Committee.

## STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1922.

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the treasurer and general manager of the Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Industrial Press, 140-148 Lafayette St., New York; Editor, Erik Oberg, 140-148 Lafayette St., New York; Managing Editor, None; Business Managers, Alexander Luchars, President, 140-148 Lafayette St., New York, and Matthew J. O'Neill, Treasurer and General Manager, 140-148 Lafayette St., New York.

2. That the owners of 1 per cent or more of the total amount of stock are: The Industrial Press; Alexander Luchars; Alexander Luchars, Trustee for Helen L. Ketchum, Elizabeth Y. Urban, and Robert B. Luchars; Matthew J. O'Neill; Louis Pelletier; and Erik Oberg. The address of all the foregoing is 140-148 Lafayette St., New York.

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager

Sworn to and subscribed before me this 18th day of September, 1922

WILLIAM E. BACON,
(SEAL) Notary Public, Kings County No. 444
Kings Register No. 3109
New York County No. 79 New York Register No. 3047
(My commission expires March 30, 1923.)

## COMING EVENTS

December 4-7—Annual convention of the American Society of Mechanical Engineers, in the Engineering Societies' Bldg., 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 7-13—National Exposition of Power and Mechanical Engineering at the Grand Central Palace, New York City. Charles F. Roth, manager, Grand Central Palace, 46th St. and Lexington Ave., New York City.

January 11-12—Annual meeting of the American Engineering Council at the new headquarters of the Federated American Engineering Societies in Washington, D. C. L. W. Wallace, 24 Jackson Place, Washington, D. C., secretary.

February 14-16—Convention of the American Institute of Electrical Engineers at the Engineering Societies' Bldg., 29 W. 39th St., New York City.

February 17-22—Exposition of inventions and patents to be held at the Grand Central Palace, New York City, under the auspices of the Universal Patent Exposition Corporation, World's Tower Bldg., 110 W. 40th St., New York City.

February 19-21—Annual meeting of the American Institute of Mining and Metallurgical Engineers at the Engineering Societies' Bldg., 29 W. 39th St., New York City.

March 18-24—Second general meeting of the International Chamber of Commerce in Rome, Italy. Lacey C. Zapf, secretary American Section, Mills Bldg., Washington, D. C.

April 30-May 3—Annual convention of the American Foundrymen's Association at Cleveland, Ohio. C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill., secretary.

## NEW BOOKS AND PAMPHLETS

**War Surplus.** Published by the Sales Promotion Section of the War Department, Office of Director of Sales, 2515 Munitions Bldg., Washington, D. C.

This booklet describes in a general way the methods of sales used by the War Department in disposing of its vast stock of surplus property, and outlines briefly what these stocks are composed of.

**Publications of the Bureau of Standards.** 199 pages, including supplement, 7 by 10 inches. Published by the Department of Commerce as Circular No. 24 of the Bureau of Standards.

This book contains a list of the scientific papers, technological papers, circulars, handbooks, and miscellaneous publications brought out by the Bureau of Standards.

**Concrete Floors and Sidewalks.** By A. A. Houghton. 63 pages, 5 by 7¼ inches; 8 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 75 cents.

This is No. 2 in a series of concrete worker's reference books. The book explains the methods of molding concrete floor and sidewalk units, and the construction of plain and monolithic floors. Complete instructions are given for the practical worker, and ample illustrations are included to make the instructions clear.

**Steel.** By Charles Rumford Walker. 157 pages, 5½ by 8 inches. Published by the Atlantic Monthly Press, Boston, Mass.

This book is the story of a graduate of Yale University, who three years ago went to work on an open-hearth furnace near Pittsburg, to learn the steel business. In this book he has put down what he saw, felt, and thought as a steel worker. The book is written from a diary of notes made in the evenings when the author was working on day shifts of ten hours. Alternate weeks he worked the fourteen-hour night shift, at which time he evidently did not devote his spare hours to writing. The book may be read as a story of men and machines, as well as a study of conditions and of the system in the steel industry.

**Belt Conveyors and Belt Elevators.** By Frederic V. Hetzel. 333 pages, 6 by 9 inches; 291 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $5.

This book was especially written for four classes of men: Men who have material to handle and who want to know more of the "how" and "why" of conveying and elevating machinery than can be told in the catalogue and advertisements of manufacturers; consulting engineers who have to advise in the selection of the proper machinery to do certain work; engineers and draftsmen who design conveying and elevating machinery; and students in technical schools and colleges. The author has been chief engineer of one of the largest companies in the conveyor business for a period of thirteen years, and has been responsible for the design of all kinds of conveying and elevating machinery. He has also acquired valuable experience in dealing directly with suggestions and complaints from users of this class of machinery, and in cooperating with them in effecting improvements in the design of this type of apparatus.

**The Welding Encyclopedia.** Compiled and edited by L. B. Mackenzie and H. S. Card of the Editorial Staff of the "Welding Engineer." 388 pages, 6 by 9 inches; 550 illustrations. Published by the Welding Engineer Publishing Co., 608 S. Dearborn St., Chicago, Ill. Price, $5.

This is the second edition of a reference book on the theory, practice and application of the four autogenous welding processes. The new edition, which contains fifty per cent more text material than the previous one, has been brought up to date, and recent developments in welding procedure, have been added. The first half of the book consists of a dictionary of all the words, terms and trade names used in the welding industry. Following the dictionary sections are chapters on oxy-acetylene welding, electric arc welding, electric resistance welding and thermit welding. Charts and tables are included, showing different methods of preparing joints for welding and giving information on the characteristics of the commoner metals. The book concludes with a catalogue section, describing and illustrating standard lines of welding equipment and apparatus.

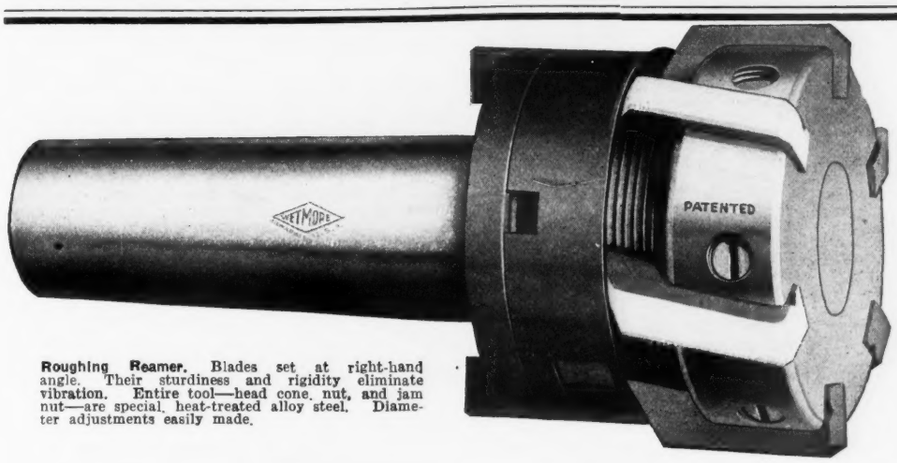
**American Malleable Cast Iron.** By H. A. Schwartz. 416 pages, 6 by 9 inches; 190 illustrations. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $7.

This book summarizes and records the present practice in making malleable cast iron. In this book the specialist may find much that appears to him elementary, and the non-technical reader may find much matter which appears too complex; but the author states that the reason for this was his desire to prepare a book that would suit many kinds of readers. This has necessitated including some elementary matter both in metallurgy and in regard to the practical application of the art of making malleable castings; on the other hand, it has necessitated that in order that the advanced reader may secure full value from this book, no known fact or theory should be excluded, even though it may appeal only to the more experienced man. The author has been very broad-minded in his treatment of the subject in that he has not considered his own views as final, but has also recorded opinions contrary to his own, so as to place on record every theory of any importance; but a constant effort has been made to record facts rather than opinions, wherever possible. This is particularly true in the chapters dealing with manufacturing methods. These chapters record what has been accomplished, rather than the theories of what might be accomplished.

**Condensed Catalogues of Mechanical Equipment.** 622 pages, 7 by 10 inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $5. (Free to members of the society.)

This is the twelfth annual edition of this classified directory of catalogue information. With this issue the size of the book has been changed and the volume is printed on special bible paper and bound in flexible "Atholeather," which makes it easier to handle, although it contains more material than any previous edition. There are three main sections in the book, the first being a classified catalogue section giving information covering the products of manufacturers of various classes of mechanical equipment; the second consists of a general classified directory of manufacturers in the mechanical field, containing a specialized cross-indexed list of mechanical equipment, with the names and addresses of manufacturers; and the third is a consulting

# THE BIG THREE

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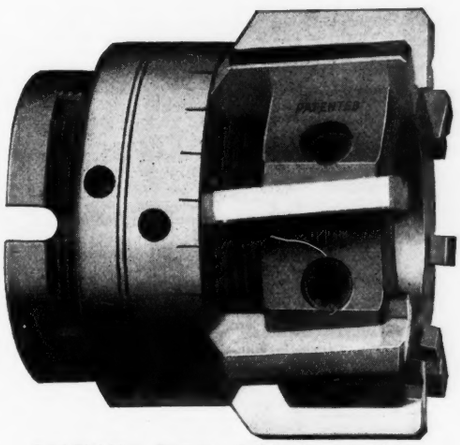

**Semi-Finishing Reamer.** Left-hand angle blades eliminate digging in and chattering. Adjustments of .001" made rapidly and accurately by means of graduated micrometer cone nut at rear of blades.

Unusual *durability* and *sturdiness*, plus *greater working speed*—that's the combination you get in the three expanding reamers of Wetmore Cylinder Reaming Sets!

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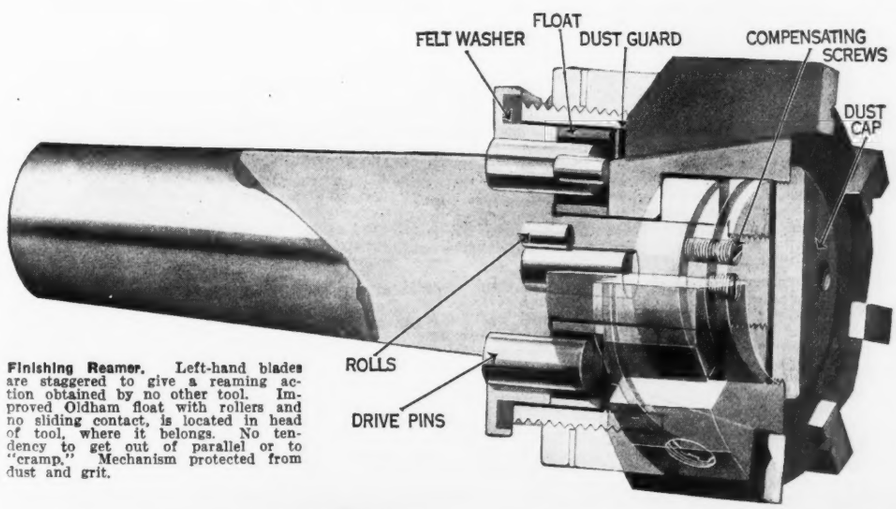


**Finishing Reamer.** Left-hand blades are staggered to give a reaming action obtained by no other tool. Improved Oldham float with rollers and no sliding contact, is located in head of tool, where it belongs. No tendency to get out of parallel or to "cramp." Mechanism protected from dust and grit.

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engineers' directory with a catalogue section, containing a classified list of members of the American Society of Mechanical Engineers engaged in the various branches of consulting engineering practice, as well as catalogue information describing the service of consulting engineers in this field. The classified directory of manufacturers contains over 3000 different subject headings, and the names and addresses of more than 4000 manufacturers.

**Mechanical Laboratory Methods.** By Julian C. Smallwood. 423 pages, 5 by 7½ inches; 112 illustrations. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $3.50.

This book deals with the testing of instruments and machines in the mechanical engineering laboratory, and with the practice of the laboratory itself. The author, who is assistant professor of mechanical engineering at Johns Hopkins University, has had an extensive experience fitting him for the preparation of such a work as this. The first edition of the work appeared in 1914. This is the third revised and enlarged edition, necessitated by new developments and by the new standards of performance that have been adopted by the power test committees of the American Society of Mechanical Engineers. The book covers, among other subjects, the calibration and testing of scales, springs, gages of various types, dynamometers, engine indicators, meters for fluids and gases, calorimeters, thermometers, pyrometers, and oil and belt testers. Then follows an analysis of combustion and a very complete detailed treatise on the testing of power plant units, including steam engines, steam pumps, boilers, steam auxiliaries, gas engines, refrigeration machinery, air machinery and water motors, together with several miscellaneous tests on pumps, hoists, lubricants, and electric motors.

**Dyke's Automobile and Gasoline Engine Encyclopedia.** By A. L. Dyke. 1226 pages, 7 by 10 inches; profusely illustrated. Published by the Goodheart-Willcox Co., Chicago, Ill. Price $6. (Bound in American morocco, $7.50.)

This is the thirteenth edition of Dyke's well-known automobile encyclopedia. This edition is enlarged and entirely rewritten, rearranged and brought up to date. The book is intended especially for three classes of users—the car owner, for whom it is a valuable reference book; the repair man, who will find in it information on every subject relating to automobile and gasoline repair work; and the student who is seeking to fit himself for the job of automobile mechanic, to whom it is doubtless the most complete textbook available. It is safe to say that no volume has as yet been brought out in the automobile field that contains within a single binding so much information as this work. One of the most valuable features of the book is the index, which contains over 14,000 entries. Every subject connected with automobile operation or repairs is treated and is indexed in three ways: (1) in relation to the construction of the car—that is, with reference to the name of the part; (2) in relation to the operation of the car; and (3) in connection with the make of the car. Thus, information on any subject contained in the book can be found almost instantly. The book contains thirteen principal sections: Assembly of the Automobile; the Automobile Electric Systems; the Storage Battery; Wiring Diagrams; Ignition and Carburetion; Tires; Garage and Shop Equipment; Repairing and Overhauling Engine and Car; Oxy-acetylene Welding, Commercial Cars; Tractors; Ford Car and Tractor; and Data, Specifications, Horsepower, and Useful Information.

## NEW CATALOGUES AND CIRCULARS

**Laclede-Christy Clay Products Co.**, St. Louis, Mo., Catalogue of Laclede-Christy stokers.

**Twin Disk Clutch Co.**, Racine, Wis. Circulars illustrating and describing the model B-1, B-10, C-8, and C-6½ twin disk clutches of the heavy-duty type.

**Wagner Electric Corporation**, St. Louis, Mo. Folder entitled "Operating Characteristics," calling attention to the advantages of the transformers built by the company.

**Climax Engineering Co.**, Clinton, Iowa. Bulletin 1001, showing typical installations of Climax engines in contractors' machinery, including tractors cranes, industrial locomotives, etc.

**R. D. Nuttall Co.**, McCandless and Harrison Ave., Pittsburg, Pa. Booklet 36, containing a series of charts on gear design, and bulletin 34, entitled "Industrial Helical Gears."

**Adolph Muehlmatt**, Lion Bldg., Fifth and Elm Sts., Cincinnati, Ohio. Folder illustrating and describing the A. M. sensitive drilling machine, an electrically driven portable bench drill.

**Link-Belt Co.**, Chicago, Ill. Calendar for 1923, which can be obtained by addressing the company at 910 S. Michigan Ave., Chicago, on a firm letter-head. The calendar measures 15½ by 24 inches.

**Osborn Mfg. Co.**, Cleveland, Ohio. Booklet entitled "All in the Day's Work," indicating how the problems of the jobbing foundry may be solved by the aid of roll-over jolt molding machines.

**Gas Producer & Engineering Corporation**, 115 Broad St., New York City. Folder entitled "On Saving Fuel and Money," calling attention to the fuel-saving possibilities of "Galusha" gas producers.

**New Departure Mfg. Co.**, Bristol, Conn. Folder entitled "Adjustability is Liability." The folder emphasizes the value of ball bearings for avoiding the slipping, sliding, wearing, and overheating likely to occur in ordinary bearings.

**National Acme Co.**, Cleveland, Ohio. Calendar illustrating on sheets for each month the various automatic screw machines, threading dies, and collapsing taps manufactured by the company at its Cleveland and Windsor plants.

**Bausch & Lomb Optical Co.**, Rochester, N. Y. Catalogue illustrating and describing the Bausch & Lomb contour measuring projector for inspecting the different elements of a screw thread or the forms of gear teeth, cutters, etc.

**Ingersoll Milling Machine Co.**, Rockford, Ill. Folder illustrating twenty-two different applications of Ingersoll milling machines, indicating the variety of machines built by the company and the wide range of work for which they are suitable.

**Dayton-Dowd Co.**, Quincy, Ill. Catalogue of centrifugal pumps dealing with the design, specifications, and manufacture of different kinds of pumps built by the company, including a number of illustrations of installations of Dayton-Dowd pumps.

**General Electric Co.**, Schenectady, N. Y. Bulletin 47002, entitled "Panels and Supporting Framework," covering types of panels, panel materials, panel sizes, vertical switchboards, framework for vertical panels, grille work and bench boards.

**Monitor Controller Co.**, Baltimore, Md. Circular entitled "Monitor Thermaload Starter," illustrating and pointing out the advantages of this device. Circular entitled "It must be Right," showing an interesting application of the Monitor controller system.

**High Speed Hammer Co.**, Inc., Rochester, N. Y. Circular illustrating and naming the working parts of high-speed riveting hammers, making it possible to order any part by number. A collection of different types of peens, anvils, and drifts are also illustrated and described.

**Crescent Pump Co.**, 743 Beaubien St., Detroit, Mich. Bulletin 5, illustrating and describing Crescent "Roto-Piston" dry vacuum pumps. Bulletin 6, illustrating and describing Crescent vacuum tools, including chucks, bench blocks, hand lifters, suction cups, old-men, and rivet hold-ons.

**E. C. Atkins & Co.**, Indianapolis, Ind. Booklet entitled "Atkins Saws in the Shop," illustrating and describing a number of the products of the company, including hacksaw blades, saw frames, metal-cutting saws, metal-cutting machines of the draw-cut and of the band-saw type, and band-saw blades.

**Logansport Machine Co.**, 529 Market St., Logansport, Ind. Catalogue of "Logan" air-operated chucks and labor-saving devices, illustrating and describing the products of the company, and showing a number of applications of air-operated chucks and holding devices on turret lathes, semi-automatic machines, automatic lathes, engine lathes, drilling machines, and milling machines.

**Racine Tool & Machine Co.**, 250 15th St., Racine, Wis. Circular describing the Racine portable band saw, duplex type, a combination wood- and metal-cutting portable band saw intended for woodworkers, pattern shops, toolrooms, trade schools, and metal workers in general. The circular completely describes the machine and illustrates its application to different classes of work.

**Geometric Tool Co.**, New Haven, Conn. Catalogue of Jarvis high-speed tapping devices, tapping machine, quick-change chucks and collets, and self-opening stud-setter. The catalogue illustrates and describes completely these various devices. Another catalogue recently brought out by the company illustrates and describes the style DS geometric screw-cutting die-heads of the self-opening and adjustable type.

**Midwest Steel & Supply Co., Inc.**, 28 W. 44th St., New York City. Architects' and engineers' data book of Midwest steel sections for overhead shafting supports, and for anchorage of piping, cables, monorails, car tracks, and various other equipment. This data book contains 53 pages, 8½ by 11 inches, giving illustrations, tables, and text matter descriptive of the uses of the Midwest box-rails, L-rails, and steel stringers.

**Sebastian Lathe Co.**, P. O. Box 729, Cincinnati, Ohio. Catalogue 27, illustrating and describing the various types of lathes built by the company, including cone pulley and geared-head quick-change lathes, as well as gap lathes, and also stud and manufacturing lathes. Various attachments are also illustrated and described, including taper attachments, draw-in attachments, turret attachments, and milling and gear-cutting attachments.

**Lodge & Shipley Machine Tool Co.**, Cincinnati, Ohio. Catalogue entitled "Examples of Turning on the Lodge & Shipley Manufacturing Lathe," showing the possibilities of an engine lathe, fitted with attachments for manufacturing purposes. The catalogue describes the Lodge & Shipley manufacturing lathe in detail, and contains illustrations showing a large number of tooling equipments for different classes of work made from photographs taken of actual set-ups.

**Mitchell Engineering Co.**, Springfield, Ohio. Booklet entitled "A Way to Reduce Polishing and Buffing Costs," illustrating and describing the company's polishing and buffing lathes, including the No. 5 double-spindle machine, which is so arranged that the spindle at each end of the machine is run independently of the other. In this machine the spindles may be run at any speed required, irrespective of the speeds obtainable from the variable-speed motor.

**Minneapolis Heat Regulator Co.**, Minneapolis, Minn. Circular illustrating and describing the Minneapolis thermostatic relay switch, a new type of switch for the thermostatic control of motors, electric heating units, and other electrical circuits. This switch has been developed particularly for use in the automatic control of oil-burning and refrigerating devices, but it has also a wide range of usefulness for the starting and stopping of motors according to temperature changes, and also for remote control work.

**Cutler Steel Co.**, Pittsburg, Pa. Bulletin 221, describing "Duraloy," a chrome-iron alloy intended for any purpose where resistance to oxidation, corrosion, and abrasion is important. This alloy is of particular value for furnace parts and heat-treating equipment, such as annealing and carburizing boxes, baskets, lead pots, and pyrometer protection tubes. It also finds general employment in chemical plants and for pumps where resistance to corrosion is of importance, and for extrusion and drawing dies and other parts where abrasive resistance is of value.

**Link-Belt Co.**, Chicago, Philadelphia, and Indianapolis. General catalogue 400, embracing the entire line of the company's products, containing 832 pages, cloth-bound. In addition to the Link-Belt line, the products of the H. W. Caldwell & Son Co.'s plant of the Link-Belt Co. are also covered. The catalogue includes chains and wheels, power transmission machinery, bearings, hangers, gears, clutches, pulleys, sheaves, elevator boots, buckets and casings, helicoid and other conveyor equipment, steel apron conveyors, belt conveyors, boiler plant equipment, coal tipple equipment, coal storage equipment, locomotive coaling stations, car loaders, locomotive cranes, electric hoists, overhead cranes, friction hoists, foundry conveyors, and equipment for numerous other installations in various industries.

**W. S. Rockwell Co.**, 50 Church St., New York City. Booklet entitled "Elements of Industrial Heating." The purpose of this booklet is to draw attention to the essential factors governing the quality and cost of products subjected to the action of heat in the process of manufacture, and the selection and use of equipment and source of heat necessary to produce better results at lower cost. The influence of heat on the quality and cost of practically all manufactured products, and the comparatively inefficient methods in general use, indicate the necessity of developing a broader view of the industrial heating problem. The book is really an educational treatise on the subject, in that it deals with and contains an unusual amount of information on the design of different kinds and types of furnaces and kindred subjects.

**Bullard Machine Tool Co.**, Bridgeport, Conn. Operator's Handbook for the Bullard Mult-Au-Matic. This book of 93 pages, 6 by 9 inches, contains complete instructions for operating Bullard Mult-Au-Matics, every effort having been made to make these instructions complete and to cover every unit and function of the machine thoroughly. The Mult-Au-Matic comprises six independent individual machine tool units incorporated in one, and coordinated in operation through the introduction of automatic control. A full understanding of the construction, functioning, adjustment, and care of the various units will add materially to the productive capacity of an installation of these machines, and this handbook is intended to make clear every point on which the operator or user would require information. The book is profusely illustrated, and a simple and direct style has been used.

**Brown & Sharpe Mfg. Co.**, Providence, R. I. Screw machine catalogue 23 G, containing 19[illegible] pages, 6 by 9 inches, descriptive of the Brown & Sharpe complete line of automatic, wire feed and plain screw machines, attachments, and tools. A new arrangement has been followed in this edition of the catalogue, the detailed descriptions of the machines being presented in the first part of the book, and condensed tables of general specifications in convenient form for comparative purposes following. Next in order are given complete specifications of all styles and sizes of machines. This grouping of specifications in one section instead of having them distributed throughout the descriptive matter is an advantage in that it enables the reader to find any desired specification readily. The catalogue contains a large number of illustrations, showing the different styles of machines, as well as detailed views of the various parts and attachments.